Atypical Cross-Modal Profiles and Longitudinal Associations Between Vocabulary Scores in Initially Minimally Verbal Children With ASD

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We tested the relative levels (i.e., age equivalencies) of concurrent cross-modality (receptive and expressive) vocabulary and the relative strength of the longitudinal, cross-modality associations between early and later vocabulary sizes in minimally verbal preschoolers with ASD. Eighty-seven children participated. Parent-reported vocabulary was assessed at four periods separated by 4 months each. Expressive age equivalent scores were higher than receptive age equivalent scores at all four periods. Cross-lagged panel analysis was used to rule out common, but trivial, explanations for differences between the longitudinal associations of interest. Key associations were tested across intervals that varied from 8 to 12 months. In two of the three tested panels, the associations between early expressive vocabulary size and later receptive vocabulary size were stronger than the associations between early receptive vocabulary size and later expressive vocabulary size, providing evidence that is consistent with the hypothesis that expressive vocabulary size drives receptive vocabulary size in minimally verbal preschoolers with ASD. *Autism Res* 2016, 9: 301–310. © 2015 International Society for Autism Research, Wiley Periodicals, Inc.

This study examines the concurrent receptive-expressive profile and the relative strength of the associations between early expressive to later receptive vocabulary sizes versus those of early receptive to later expressive vocabulary sizes in initially minimally verbal children with autism spectrum disorder (ASD). One reason the relative strength of these associations is of interest is that such an association might explain the atypically high levels of expressive language relative to receptive language in some children with ASD. Before elaborating on these findings, we first lay out the reasons many scientists expect receptive language to drive expressive language in typically developing children.

The Typical Profile and Longitudinal Relation Between Receptive and Expressive Vocabulary

In typical development, receptive vocabulary is thought to precede and drive expressive vocabulary [Bornstein & Hendricks, 2012]. This presumption is based in part on the fact that absolute receptive vocabulary size typically exceeds absolute expressive vocabulary size. For example, it has long been noted that typically developing children understand their first 50 words at approximately 13 months, which is much earlier than they produce 50 different words at approximately 18 months [Benedict, 1979]. The hypothesis that reception drives expression is further supported by the fact that early receptive language predicts later expressive language in typically developing children [Tamis-Lemonda, Bornstein, Kahana-Kalman, Baumwell, & Cyphers, 1998; Watt, Wetherby, & Shumway, 2006]. However, to our knowledge, the relative strength of cross-modal longitudinal associations between receptive and expressive vocabulary have not been directly compared within the same sample of typically developing children.

Prior Evidence Regarding an Atypical Receptive-Expressive Profile in Children With ASD

Several studies have reported that children with ASD may have receptive language levels that are lower than their expressive language levels, or have smaller than expected gaps between their receptive and expressive language levels [Barbaro & Dissanayake, 2012; Charman, Drew, Baird, & Baird, 2003; Ellis Weismer, Lord, & Esler, 2010; Luyster, Kadlec, Carter, & Tager-Flusberg, 2008; Maljaars, Noens, Scholte, & van Berckelaer-Onnes, 2012; Pickles, Anderson, & Lord, 2014; Volden et al., 2011]. These findings do not necessarily mean

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that children with ASD say more than they understand, but do suggest that some children with ASD have more limited receptive language skills than expected relative to their expressive language skills. Almost all of these studies use age equivalency scores as the metric for vocabulary or broader spoken language levels. A reduced receptive age equivalent relative to expressive age equivalent is atypical because the tables used to convert raw scores to age equivalency scores are designed in such a way that receptive and expressive language age equivalency levels should be approximately equal for most typically developing children.

Despite the evidence summarized above, there is a need for more study regarding this atypical language profile. The atypical expressive-receptive profile has not been found across all studies or for all children with ASD [Kwok, Brown, Smyth, & Cardy, 2015]. Although a few studies have found evidence of a "reduced receptive advantage" in early stages of development [i.e., in infants and toddlers later diagnosed with ASD; Barbaro & Dissanayake, 2012; Hudry et al., 2014], other results suggest that a receptive disadvantage is only apparent in children with ASD who are developmentally more advanced (i.e., higher in chronological age, nonverbal mental age, and/or language level) than the current sample [Hudry et al., 2010; Kjelgaard & Tager-Flusberg, 2001; Pickles et al., 2014]. Thus, it is not entirely clear whether an atypical receptive-expressive profile would be observed in the present sample of preschoolers with ASD, who were preverbal or in the "first words" stage of language learning [Tager-Flusberg et al., 2009] and who had broader cognitive impairments at entry to our study (refer to Table 1).

Atypical Longitudinal, Cross-Modal Associations Between Early and Later Vocabulary May Explain Atypical Profiles in Children With ASD

Children with ASD may have expressive vocabulary levels (e.g., age equivalent scores) that are higher than one would typically expect given receptive vocabulary levels at a given point in time because expressive vocabulary size might have an atypically strong influence on (i.e., drive) receptive vocabulary size in at least some children on the autism spectrum. One way to test whether expressive vocabulary size "drives" receptive vocabulary size is to examine the longitudinal associations between the two modalities. Finding that the relation between early expression and later reception is greater than the relation between early reception and later expression would be consistent with the hypothesis that expression atypically influences reception in preschoolers with ASD in the early stages of language learning.

Researchers have called for the use of longitudinal data to elucidate the relation between expressive and receptive abilities of children with ASD [e.g., Ellis Weismer et al., 2010; Volden et al., 2011]. To our knowledge, only three previous studies have evaluated the possible "reduced receptive advantage" longitudinally in children with ASD. Two of these studies [Barbaro & Dissanayake, 2012; Hudry et al., 2014] involved only infants and toddlers (i.e., not preschoolers) with ASD, and the third [Pickles et al., 2014] used a measure of expressive and receptive language that appears to be somewhat insensitive to receptive deficits in children with ASD [see the discussion section of Luyster et al., 2008 for an overview re: sensitivity of the Vineland Adaptive Behavior Scales to receptive deficits in ASD]. None of the aforementioned studies examined whether the association of early expressive vocabulary size to later receptive vocabulary size is greater than the association of early receptive vocabulary size to later expressive vocabulary size in preschoolers with ASD.

Hypotheses of Current Study

We had two hypotheses. First, we expected expressive age equivalency scores to exceed concurrent receptive age equivalency scores in minimally verbal preschoolers with ASD. Second, we expected that the association of early expressive vocabulary size to later receptive vocabulary size would be significantly larger than the association of early receptive vocabulary size to later expressive vocabulary size for this subgroup of children with ASD. An exploratory analysis is included to examine whether the difference between expressive and receptive vocabulary levels varies with time. We focus on vocabulary because this aspect of language is the most appropriate focus of research for children with ASD who are preverbal or primarily still communicating with a small number of single words [Bates, Dale, & Thal, 1995; Tager-Flusberg et al., 2009].

Methods

Design Overview

The research design elements used in this study were (a) a nonexperimental, within-subjects comparison of receptive and expressive levels and (b) a longitudinal correlational design. In the larger study from which the data are drawn, parents of initially minimally verbal preschoolers with ASD reported their children's expressive and receptive vocabulary on a commonly used checklist at five time points separated by approximately 4 months each [Yoder, Watson, & Lambert, 2015]. However, as there was too little variance in child

Table 1. Participant Characteristics

Variable	Mean	Standard Deviation
Chronological age in years	3.3 years	.6 years
MCDI words understood	115 words	110 words
MCDI words said	18 words	30 words
MSEL mental age	12.1 months	4.7 months
MSEL expressive language age	8.0 months	4.2 months
MSEL receptive language age	6.4 months	6.2 months
ADOS Module 1 social communication total	22.6	3.8

Note. Chronological age is at Time 1 for current analyses. MCDI = MacArthur-Bates Communicative Development Inventory. MCDI measures are at Time 1 of current analyses. MSEL = Mullen Scales of Early Learning. ADOS = Autism Diagnostic Observation Schedule. MSEL and ADOS were administered at entry to the larger study from which the present data were drawn (i.e., 4 months prior to Time 1 for this study). MSEL mental age is the average age equivalency score from Visual Reception, Fine Motor, Receptive Language, and Expressive Language subscales. Given the selection criteria for entry to the larger study, ADOS Module 1, intended for children who are preverbal or using only single words to communicate, was appropriate for all participants.

expressive vocabulary size at entry to the larger study to model the longitudinal associations across modalities, Time 1 for this study was 4 months after entry to the larger project. Thus, four measurement periods are relevant to the current report. We examined concurrent cross-modal profiles at each measurement period. We examined the cross-lagged associations (i.e., an early measure of one variable to a later measure of another variable) between receptive and expressive vocabulary across three longitudinal intervals or panels: (a) the 8-month interval between Time 1 and Time 3 (Panel 1), (b) the 8-month interval between Time 2 and Time 4 (Panel 2), and (c) the 12-month interval between Time 1 and Time 4 (Panel 3). Eight- and 12-month intervals were selected to allow sufficient time for change in the individual differences in vocabulary to occur in initially minimally verbal children with ASD.

Participants

Participants included 87 children (71 male and 16 female) with ASD. At the time they entered the larger study [Yoder et al., 2015] from which the data of interest was drawn, these children (a) were between 24 and 48 months chronological age; (b) had a clinical diagnosis of ASD based on criteria in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition-Text Revision [American Psychiatric Association, 2000] and confirmed by the Autism Diagnostic Observation Schedule [Lord et al., 2000]; (c) were reported to say no more than 20 different words according to parent report on the MacArthur-Bates Communicative Development Inventories: Words and Gestures checklist (MCDI) [Fenson et al., 2003]; and (d) produced no more than five different word roots during a 15-min language sample. We additionally excluded children with severe sensory or motor impairments, identified metabolic or progressive neurological disorders, and identified genetic syndromes.

Descriptive statistics on child variables are presented in Table 1. The formal educational levels of the partici-

pants' primary caregivers were distributed as follows: 4 had less than a high school education, 19 had a high school diploma or equivalent, 21 had one to 2 years of college or technical school education, 28 had 3–4 years of college or technical school education, and 15 had attended graduate or professional school.

Vocabulary Measure

Parents reported their children's receptive and expressive vocabulary on the MCDI [Fenson et al., 2003] vocabulary checklist at all four time points relevant to this study. For the longitudinal correlations, the raw score was used because doing so enabled maximum sample size and appropriate imputation. For the concurrent cross-modal vocabulary level comparisons, age equivalency scores were used because it is developmental level, not absolute vocabulary size, that is typically similar across modalities and that we thus predicted to favor the expressive modality in children with ASD. Age equivalency scores were the ages for children in the fitted 50th percentile in the pooled sexes conversion chart in the MCDI technical manual [Fenson et al., 2003].

Analytic Approach

The research design and cross-lagged panel analysis allow us to demonstrate that the most common alternative explanations for differences in the cross-modality associations between early to later vocabulary sizes do not account for our findings [Kenny, 1975]. Additionally, the method that we use to compare the magnitude of the cross-lagged, cross-modal correlations adjusts the test statistic using the concurrent correlations and the temporal stability of the two variables [Raghunathan, Rosenthal, & Rubin, 1996]. Although no correlational design can rule out all alternative explanations, differences in the cross-lag associations between modalities are compatible with an interpretation that one modality has a superior impact on the other. In other words, the cross-lagged panel analysis and longitudinal

Table 2. Associations of Interest in the Cross-Lagged Panel Design

Variable	Variable			
	Receptive at early period	Expressive at early period	Receptive at later period	Expressive at later period
Receptive at early period	1	AB	AX	**AY**
Expressive at early period		1	**BX**	BY
Receptive at later period			1	XY
Expressive at later period				1

Note. Bold font indicates the cross-lagged, cross-modal associations compared for each panel of interest. Non-bolded associations are taken into account in making the cross-lagged, cross-modal comparison.

research design increases the extent to which correlational evidence indicates whether earlier expressive vocabulary has a greater influence on later receptive vocabulary than earlier receptive vocabulary has on expressive vocabulary for each of the three timeframes of interest.

For each of the three panels, we evaluated the magnitude of the correlations for the association between early receptive vocabulary and later expressive vocabulary relative to the association between early expressive vocabulary and later receptive vocabulary using a statistic called ZPF [Raghunathan et al., 1996]. ZPF is a modified Pearson-Filon statistic, which compares the magnitude of two correlated, but nonoverlapping, correlation coefficients that have been transformed into *z*-scores using Fisher's *r* to *z* transformation. The ZPF has been found to have superior statistical properties compared to the Pearson-Filon statistic, an older approach used in previous cross-lagged panel design studies [Raghunathan et al., 1996]. The ZPF for each panel was derived using the ZPF.SAS script developed by Weaver and Wuensch [2013].

Table 2 depicts a correlation matrix that may be helpful for understanding how a single cross-lag panel analysis works and for interpreting our results. The labels (e.g., AY) are also used in the table of results for cross-lagged panel analyses (as reported in Table 3 of the Results) to aid communication about associations. We are interested in whether the magnitude of the association between early receptive vocabulary and later expressive vocabulary (the AY relation) differs from the magnitude of the association between early expressive vocabulary and later receptive vocabulary (the BX relation) in our sample of minimally verbal children with ASD. Finding such a difference in a cross-lagged panel analysis suggests that the larger correlation represents the stronger direction of effect. When evaluating the difference between these two *z*-transformed correlation coefficients, we also take into account the extent to which scores within each modality are associated across time points (the AX and BY relations) and the extent to which scores across modalities are concurrently associ-

ated at each time point (the AB and XY relations). When correlations within modality across time points (AX and BY) are similar in magnitude, we can be confident that a difference in cross-lagged correlations is not due to the predictor in the larger cross-lagged association being more temporally stable than the predictor in the smaller cross-lagged association [Kenny, 1975]. Positive concurrent associations across modalities (AB and XY) are consistent with the interpretation that the larger cross-lagged correlation indicates the predictor positively influences the criterion variable [Kenny, 1975].

Results

Transformation of Variables

The analytic approach assumes multivariate normality and multivariate normality is more likely when univariate distributions do not grossly depart from the normal distribution [Tabachnick & Fidell, 2001]. Thus, all variables were evaluated for normality. Variables showing univariate skewness $> |0.8|$ or kurtosis $> |3.0|$ were transformed prior to imputation and analysis. MCDI expressive vocabulary raw scores were log-10 transformed to correct for a severe positive skew that was present at all time points. The MCDI receptive vocabulary raw scores were square root transformed to correct a moderate positive skew that was observed for Time 1 and Time 2. No age equivalency scores required transformation.

Table 3. Means, SDs, Within-Subject Cohen's *d*, and 95% Confidence Interval for Concurrent Contrast Between Expressive and Receptive Vocabulary Ages in Months

Period	Expressive age M(SD)	Receptive age M(SD)	*d*[95% CI]
1	12.5(2.6)	11.4(3.0)	0.37[0.10, 0.64]**
2	13.3(2.8)	12.2(3.3)	0.34[0.09, 0.58]**
3	14.2(3.5)	13.3(3.9)	0.24[0.0004, 0.48]*
4	14.9(3.8)	14.0(3.4)	0.24[0.0005, 0.47]*

Note. *P < 0.05; **P < 0.01.

Table 4. Zero-Order Correlations, Test Statistic, and *P* Value for the Cross-Lagged Panel Comparisons of the Associations Between Early to Late Comprehension and Production Vocabulary

	Panel 1 Time 1–Time 3	Panel 2 Time 2–Time 4	Panel 3 Time 1–Time 4
Association **AY**	**Receptive at Time 1 to Expressive at Time 3**	**Receptive at Time 2 to Expressive at Time 4**	**Receptive at Time 1 to Expressive at Time 4**
R	**0.39*****	**0.42*****	**0.28***
Association AB	Receptive at Time 1 to Expressive at Time 1	Receptive at Time 2 to Expressive at Time 2	Receptive at Time 1 to Expressive at Time 1
R	0.50***	0.58***	0.50***
Association AX	Receptive at Time 1 to Receptive at Time 3	Receptive at Time 2 to Receptive at Time 4	Receptive at Time 1 to Receptive at Time 4
R	0.75***	0.83***	0.82***
Association BY	Expressive at Time 1 to Expressive at Time 3	Expressive at Time 2 to Expressive at Time 4	Expressive at Time 1 to Expressive at Time 4
R	0.82***	0.80***	0.71***
Association XY	Receptive at Time 3 to Expressive at Time 3	Receptive at Time 4 to Expressive at Time 4	Receptive at Time 4 to Expressive at Time 4
R	0.58***	0.53***	0.53***
Association **BX**	**Expressive at Time 1 to Receptive at Time 3**	**Expressive at Time 2 to Receptive at Time 4**	**Expressive at Time 1 to Receptive at Time 4**
R	**0.49*****	**0.57*****	**0.57*****
ZPF	−1.16	−1.94	−3.31
P	0.25	0.05	<0.001

Note. Bolded coefficients are for associations of primary interest. ZPF is the test statistic for the difference between the nonindependence-adjusted difference in the correlations for bolded correlations. For zero-order correlations

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$ for the comparison with zero.

The Handling of Missing Data

For the tests of differences in the longitudinal cross-modality associations, missing data were multiply imputed [Enders, 2011]. Briefly, multiple imputation involves generation of multiple data sets (e.g., 40) with plausible values for missing data points based on the strength and direction of associations with other variables that have observed scores, analysis of each filled-in data set, and pooling of the information from the multiple data sets into a single result. This method is preferable to traditional methods for dealing with missing data (e.g., deletion, single imputation, last observation carried forward) in longitudinal data sets because it reduces bias and preserves statistical power to detect effects of interest [Enders, 2011]. When imputing missing values, we included "auxiliary variables," which are ancillary to the primary research questions, to improve the accuracy of imputation [Collins, Schafer, & Kam, 2001; Enders, 2011]. The auxiliary variables included are indicated in Yoder et al. [2015].

When testing the concurrent relative levels of vocabulary across modalities, filtering and listwise deletion were used. We chose to filter our participants whose raw score on the receptive scale exceeded the maximum in the conversion table for the Word and Gestures scale of the MCDI. If we had not done so, receptive age equivalency scores could not continue to grow over time, which could have artificially altered the discrepancy between receptive and expressive levels at later periods. We chose to use listwise deletion because we wanted readers to be able to compare the within-group effect size for the difference between expressive and receptive levels across periods. Doing so required using the same participants among periods. This resulted in reducing the sample size for the concurrent, within-group, cross-modality vocabulary comparisons to 58.

Primary Analyses

Table 3 summarizes the means, SDs, and effect sizes for the differences between expressive and receptive vocabulary age equivalency scores at each measurement period of interest in this study. Expressive age exceeded receptive age at all periods. The effect sizes are between small and moderate. The effect size of the difference between expressive and receptive vocabulary levels did not vary with time; Time × Modality effects for linear, quadratic, and cubic functions all had p values > 0.54.

Expressive language age additionally was observed to significantly exceed receptive language age on the Mullen Scales of Early Learning (MSEL) [Mullen, 1995] when children entered the larger study from which the data of interest in this report was drawn (as shown in Table 1), $t(86) = 2.375$, $p < 0.05$, two-tailed. The MSEL was the one additional standardized measure from the

larger study for which receptive and expressive age equivalency scores were available. This measure was only collected at Time 1 for the larger study and thus could not be used to evaluate concurrent expressive versus receptive profiles at subsequent time points.

Table 4 summarizes the results of the longitudinal analyses. There were significantly stronger associations between early expressive and later receptive vocabulary sizes than between early receptive and later expressive vocabulary sizes for Panel 2 (Time 2–4) and Panel 3 (Time 1–4). A similar trend was reflected in the correlation coefficients for earlier to later cross-modal associations in Panel 1 (Time 1–3), but the difference for this interval did not reach statistical significance. In all three panels, concurrent associations across expressive and receptive modality scores are positive and the temporal stability of measures of vocabulary size is similar and nonsignificantly different between the two modalities.

The same pattern of results was observed when cross-lagged panel analyses were carried out using indices derived from the Communication and Symbolic Behavior Scales (CSBS) [Wetherby & Prizant, 2002], the one standardized measure of reception and expression that was available for all relevant time points for the larger study of useful speech development from which this data was drawn. In these post hoc analyses, the weighted raw scores for the "Words" and "Comprehension" subscales of the CSBS were used as the variables for expression and reception, respectively. There were significantly stronger associations between early expression and later reception than between early reception and later expression for two of three panels of interest (ZPFs = 1.8 and 1.62, respectively, for the two panels reaching statistical significance, p values < 0.05, one-tailed). The third panel showed a similar trend, but did not reach statistical significance ($p = 0.10$).

Discussion

The results of this study are compatible with our predictions that (a) expressive level exceeds receptive level and (b) the cross-modality, longitudinal association between early expressive and later receptive vocabulary sizes is stronger than the complementary cross-modal association in minimally verbal preschoolers with ASD. Both findings indicate an atypical relation between expressive and receptive vocabulary in children with ASD who are in early stages of language development. Before discussing these results, we acknowledge the limitations of this correlational design and analysis.

Limitations

This study's correlational design supports two of the three criteria for inferring that expression influences reception: (a) a noteworthy positive association and (b)

expression measured prior to reception. One key limitation of this study, however, is that the correlational design does not afford a confident inference that expression causes reception. Such designs cannot rule out all alternative explanations to the longitudinal association [Cohen, Cohen, West, & Aiken, 2003]. Even showing the stronger expression-to-reception association is insufficient to infer expression influences reception because there are potential uncontrolled explanations for the difference between associations [Rogosa, 1980].

Another limitation of this study is that participants were initially selected based on having little or no expressive vocabulary. In addition, for our comparisons of the concurrent cross-modality vocabulary profiles, children whose receptive vocabularies were too large to derive age-equivalent scores from the MCDI manual were deleted. These factors constrain the generalizability of our findings to preschool children with ASD who have very limited expressive and receptive vocabularies. Additional research is needed to determine the extent to which the present results extend to children with ASD who have more extensive vocabularies in either modality or who differ in other potentially important ways from the children enrolled in this study.

Relation of the Current Finding of an Atypical Vocabulary Profile to Past Work

Our findings add to the past literature describing atypical expressive-receptive profiles for subgroups of children with ASD [Barbaro & Dissanayake, 2012; Charman et al., 2003; Ellis Weismer et al., 2010; Kjelgaard & Tager-Flusberg, 2001; Luyster et al., 2008; Maljaars et al., 2012; Pickles et al., 2014; Volden et al., 2011]. Our sample of preschoolers with ASD was minimally verbal and cognitively impaired. Thus, our findings are consistent with studies suggesting that disproportionate deficits in receptive language level given expressive language level may be evident in the earliest stages of language development for children with ASD [e.g., Barbaro & Dissanayake, 2012; Hudry et al., 2014]. However, our result contrasts with some past work suggesting that atypical expressive-receptive profiles are only apparent in children with ASD who are chronologically older or developmentally more advanced than the present sample [e.g., Hudry et al., 2010; Pickles et al., 2014]. Other studies have failed to find any significant differences between receptive and expressive language levels [e.g., Jarrold, Boucher, & Russell, 1997; Loucas et al., 2008] or in some instances even observed receptive levels that appear to be advanced relative to expressive levels in children with ASD [Ellis Weismer et al., 2010; Luyster et al., 2008]. Thus, findings across the larger literature are not consistent.

The reasons for the discrepancies across studies are not yet clear. In a recent meta-analysis, Kwok et al. [2015] conclude that inconsistencies regarding receptive-expressive profiles across samples of children with ASD cannot be explained by chronological age of participants (i.e., dichotomized younger vs. older categories), language domain assessed (i.e., vocabulary vs. broader spoken language ability), type of language measure used (i.e., caregiver report, clinician administered, or mixed methods), or method of ASD diagnosis (gold standard or other). Future studies in this area should examine whether findings for atypical receptive-expressive profiles and longitudinal associations in ASD vary according to other factors. For example, we suspect that *developmental stage* may contribute to profiles more than *chronological age*. Unfortunately, this study cannot address this issue because our sample was limited to a subset of children with ASD who were homogeneous in terms of both their developmental stage (i.e., children were in the first words stage of language development) and their chronological age (i.e., children were all preschool-aged). Furthermore, results may vary based on the *specific measure* used as opposed to the *broad type* of measure used. Along these lines, findings across several studies collectively suggest that the Vineland Adaptive Behavior Scales is less sensitive to atypicalities in receptive and expressive language in ASD relative to other parent-report measures, such as the MCDI, at the earliest stages of development [Ellis Weismer et al., 2010; Hudry et al., 2014; Luyster et al., 2008; Pickles et al., 2014]. Finally, the metric used in analysis may also influence findings. Age equivalency scores are more informative regarding children's relative expressive and receptive language *levels* versus standard scores, which reflect children's status relative to typically developing peers of approximately the same age.

A Mechanism by Which Expressive Vocabulary May Drive Receptive Vocabulary in Children With ASD

Further research is also needed to determine (a) why some children with ASD show deficits in receptive vocabulary levels that are disproportionate relative to their expressive vocabulary levels and (b) how expressive vocabulary size might drive receptive vocabulary size in minimally verbal children with ASD. We suspect that the reduced receptive advantage that has been observed for some children with ASD results from such children deriving less benefit from the broad range of adult linguistic input that supports receptive vocabulary learning in typically developing children. For example, typically developing children are easily able to shift attention and follow an adult's lead to successfully map word forms to referents/word meanings as early as the infant and toddler years, whereas children with ASD

often require more "supportive" contexts to learn new word meanings [Baldwin, 1993; Baron-Cohen, Baldwin, & Crowson, 1997].

Indeed, past work involving a sample of minimally verbal preschool children with ASD that partially overlaps with the present sample found that only adult linguistic input that occurs in "high level supported joint engagement" between parent and child correlated with later receptive language, above and beyond parental input provided in other engagement states [Bottema-Beutel, Yoder, Hochman, & Watson, 2014]. High level supported engagement occurs when children coordinate attention to person and object without gazing at the parent (e.g., as may occur in object exchange). Linguistic input provided in other engagement states did not show such value-added prediction of later receptive language. The same study found that preschool children with ASD who had relatively higher expressive language were more able to participate in high level supported joint engagement than children with lower expressive language ability [Bottema-Beutel et al., 2014]. Thus, we suspect that children with ASD who have larger expressive vocabulary sizes more frequently become engaged in high level supported joint engagement states, which in turn provide a context in which parents may provide input from which children with ASD might be particularly likely to learn new receptive vocabulary. This mechanism is expected to be salient primarily during the early stages of language learning in children with ASD.

Clinical Implications

The present findings for an atypical relation between expression and reception in preschoolers with ASD may indicate a need to think differently about the treatment of reception and expression for this population [Gillum & Camarata, 2004]. There is a long-standing controversy regarding when and how we should teach receptive and expressive vocabulary in children with ASD. Although conventional thinking and many current treatment protocols recommend following the "typical" developmental sequence and teaching reception prior to expression, there is little empirical support for this suggestion in children with developmental disabilities [see Petursdottir & Carr, 2011 for a fairly recent review]. In fact, some evidence suggests that teaching expression prior to reception, or even solely targeting expression, might be more effective or efficient in young children with ASD [Watters, Wheeler, & Watters, 1981; Wynn & Smith, 2003].

However, researchers who have taught expression prior to reception or targeted reception separate from expression have failed to find consistent cross-modality generalization in either direction in children with ASD,

particularly in the early stages of language development [Castle & Camarata, 2012; Wynn & Smith, 2003]. In other words, targeting the expressive use of words "first" or "only" in treatment does not necessarily guarantee understanding of words for young children with ASD who are just beginning to talk. Thus, at present it appears that clinicians might most effectively and efficiently target vocabulary in children with ASD who are in the "first words" stage of language learning by beginning to target the expressive use of words, but should always be careful to monitor for whether understanding of words is coming along or needs to be directly taught.

A Need for Additional Research Into Best Clinical Practices

Notably, the literature on how we might best target expressive and receptive vocabulary in children with ASD is extremely limited. The research that favors teaching expression prior to reception or targeting expression with the hope of generalization to reception in children with ASD is limited to a few single case studies in which a small number of participants have been taught only a limited number of target word sets. To our knowledge, no large scale studies to date have attempted to determine whether teaching expression as measured more globally (e.g., number of words used or expressive vocabulary level) translates to gains in reception as measured more globally (e.g., number of words understood or receptive vocabulary level). Experimental studies that treat expressive vocabulary as a broad goal and measure later receptive vocabulary would be needed to test a causal cross-modal link in children with ASD. These studies would allow us to test whether effects of treatment on later reception are preceded and mediated by earlier effects on expression. Confirming such a mediation relation in a well-controlled, experimental study would allow us to conclude that effects on expressive vocabulary size translate to gains in receptive vocabulary size.

In conclusion, this study is the first to demonstrate that the longitudinal expression-to-reception association is stronger than the reception-to-expression association in minimally verbal preschoolers with ASD. This atypical pattern warrants further study to explicate its origins (i.e., to determine whether it occurs due to expression influencing reception and, if so, by what mechanism) and to test whether competing treatment methods motivated by the findings (i.e., treatment of expressive vocabulary first vs. receptive vocabulary first, or expressive and receptive vocabulary simultaneously) yield differential results.

Acknowledgments

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