HHS Public Access

Author manuscript

Autism Res. Author manuscript; available in PMC 2019 May 01.

Published in final edited form as:

Autism Res. 2018 May ; 11(5): 755–765. doi:10.1002/aur.1928.

Bidirectional Influences of Caregiver Utterances and Supported Joint Engagement in Children with and without Autism Spectrum Disorder

Kristen Bottema-Beutel[1],
Lynch School of Education, Boston College

Blair Lloyd,
Department of Special Education, Vanderbilt University

Linda Watson, and
University of North Carolina- Chapel Hill

Paul Yoder
Department of Special Education, Vanderbilt University

Abstract

This study examined *sequential associations* between pairs of caregiver talk and caregiver-child joint engagement categories. Sequential associations quantify the extent to which one event (such as a particular type of caregiver talk) follows another event (such as a particular type of joint engagement) in a pre-specified time window, while controlling for the chance occurrence of the sequence. Although unable to support strong conclusions about causality, the requirement of sequential analysis that key events occur within a close temporal sequence rules out alternative explanations for associations that summary-level correlations cannot. We applied sequential analysis to observational data on 98 caregiver-child dyads, fifty of which included a child with autism spectrum disorder (ASD). Groups were matched on mental age, and all were just beginning to develop spoken vocabulary. Sequential associations between supported joint engagement and caregiver follow-in utterances were stronger in ASD dyads as compared to dyads with typically developing children. Further, sequential associations between utterances related to the child's focus of attention followed by higher order supported joint engagement (HSJE) were stronger than between utterances that related to the caregiver's focus of attention and HSJE, across both groups. Finally, sequential associations between follow-in directives followed by HSJE were stronger than between follow-in comments followed by HSJE, again across both groups of children.

Keywords

Autism spectrum disorder; Supported joint engagement; Caregiver Talk; Sequential Analysis; Responsivity

[1]Corresponding Author. Address: 140 Commonwealth Ave., Chestnut Hill, MA 02467, Telephone: (617) 552-0368; Kristen.bottema-beutel@bc.edu.

The authors report no conflicts of interest.

Joint engagement, wherein young children and their caregivers are mutually involved with objects, has long been recognized as an interaction format that is instrumental in children's development. Particular forms of joint engagement have been shown to positively influence language acquisition in both children with autism spectrum disorder (ASD) and typically developing (TD) children, and to positively influence social-communication development in children with ASD (Adamson, Bakeman, Deckner, & Romski, 2009; Bakeman & Adamson, 1984; Bottema-Beutel, Yoder, Hochman, & Watson, 2014). When caregivers talk about what their children are doing (termed 'follow-in utterances') during particular forms of joint engagement, children have the opportunity to increase their receptive vocabularies (Adamson et al., 2009; Bottema-Beutel et al., 2014). Because joint engagement has been shown to influence developmental milestones, and because it is a malleable phenomenon that can be facilitated by caregivers (or other adults), it has been a primary target for developmentally-focused interventions for young children with ASD (Kasari, Freeman, & Paparella, 2006; Kasari et al., 2014).

Longitudinal Correlates of Joint Engagement and Caregiver Talk

This study is part of a series of studies that have attempted to refine our understanding of the interplay between caregiver-child joint engagement, caregiver talk, and child development in children with ASD and TD who are just beginning to speak (Bottema-Beutel et al., 2014; Bottema-Beutel, Malloy et al., 2017; Bottema-Beutel, Woynaroski, et al., 2017). Our first study (Bottema-Beutel et al., 2014) suggested that supported joint engagement (SJE), previously shown to be a superior predictor of language in comparison to other forms of joint engagement, could be separated into two distinct subtypes. In SJE, caregivers influence their children's play with toys, but the child does not explicitly acknowledge the interaction partner or manage the interaction by gazing to the adult's face (Adamson et al., 2009). This super-ordinate category can be broken down into 'higher' and 'lower' order sub-types, which vary in the extent to which the child reciprocally engages with the caregiver during play. In *higher-order* supported joint engagement (HSJE), the child's play is influenced by the caregiver, and the child shows reciprocity with the caregiver (e.g., via turn taking or imitation), albeit without making eye contact with the caregiver. In *lower-order* supported joint engagement (LSJE) the caregiver influences the child's play with the toys, but the child does not explicitly show reciprocity with the caregiver, nor do they make eye contact. Each of these states can be contrasted with *object engagement* where the child plays with toys, and the caregiver does not influence the child's play.

HSJE was longitudinally associated with child social-communication, and when it occurred along with caregiver follow-in utterances (i.e., utterances that are semantically related to the child's focus of attention), it was longitudinally associated with receptive language (Bottema-Beutel et al., 2014). In both cases, associations were present even after controlling for LSJE or LSJE that co-occurred with follow-in utterances, respectively. In a follow-up study, we found that HSJE that co-occurred with follow-in utterances mediated the association between early expressive and later receptive vocabulary, but only for children with ASD and not children with TD (Bottema-Beutel et al., 2017). This suggests that particular child abilities (e.g., expressive vocabulary) may recruit caregivers to talk about their child's focus of attention during HSJE, and that this particular format of caregiver-child

engagement may be more critical for receptive vocabulary development in children with ASD as compared to children who are TD.

Sequential Relationships between Caregiver Talk and Child Play/ Engagement

Recently, we have shifted our attention from longer-term, longitudinal associations to more immediate, sequential associations between caregiver and child variables. Sequential associations quantify the extent to which the occurrence of one key event alters the momentary probability of another key event. Positive associations indicate the occurrence of the first event increases the momentary likelihood of the second event (relative to when the first event is absent). Although non-experimental designs do not allow for causal claims, by specifying a very specific time window in which the second event must occur after the first event, sequential analysis eliminates many of the third variable explanations that summary-level correlations cannot. Additionally, sequential analysis quantifies the extent to which the two phenomena occur in an expected sequence, while controlling for the extent to which the sequence could have occurred by chance. When one or both phenomena are very frequent, chance occurrences of the sequence of interest will be higher than when both event types are infrequent. When properly quantified, sequential associations can be compared across different groups of children (i.e., children with ASD vs. children who are TD) to determine if temporal links are stronger in one group relative to the other. Associations also can be compared across different event pairs to determine if some event pairings are more tightly linked than others.

In a previous study, we examined sequential associations between caregiver talk and child play in children with ASD as compared to TD (Bottema-Beutel, Malloy, et al., 2017). We found that child toy play was more likely to elicit caregiver follow-in utterances when caregiver-child dyads included a child with ASD as compared to a TD child. This indicates that caregivers of children with ASD may take particular care to time their follow-in utterances so that they occur when their child is actively playing with a toy. These caregivers may notice that their children are particularly likely to be influenced by their talk if it follows moments of engagement with toys. Because TD children may be influenced by caregiver's talk regardless of when it is given, caregivers of TD children may not be motivated to time their utterances in such a manner, and may provide follw-in utterances regardless of whether their child is actually playing with the object that is their focus of attention.

We also found that follow-in utterances were more likely to elicit functional play (the highest level of play shown by the young children included in the study) than utterances related to the caregiver's focus of attention. This was especially true for the children with ASD as compared to TD children. This may be because children with ASD are more reliant on utterances tailored to their focus of attention to engage in play than are TD children. Finally, follow-in directives (a sub-category of follow-in utterances where the caregiver proposes something new for the child to do with toys the child is already playing with) were more likely to elicit functional play than follow-in comments (when the caregiver describes

the state of affairs regarding the toys the child is playing with). This finding was consistent across both ASD and TD groups, and suggests that, for young children who are not yet speaking, directives may be critical to engage in advanced levels of toy play.

Current Study

Understanding the sequential relationships between caregiver talk and joint engagement states may be useful for refining intervention designs, especially those for which joint engagement is purported to be an 'active ingredient' (Kasari et al., 2006). By identifying and encouraging the types of caregiver talk that elicit developmentally important engagement states, the time children spend in those states can be maximized (Gulsrud, Hellemann, Shire, & Kasari, 2016). Further, sequential analysis is a methodologically rigorous strategy for examining caregiver responsivity (in terms of their talk) to particular engagement states, as it controls for the chance sequencing of caregiver talk after particular engagement states. This is useful because, without controlling for chance, our measures of responsivity are influenced by the base rates of the events of interest. This is undesirable because it is the link between the two, not the chance sequencing of engagement states and caregiver responses that we mean to examine.

By investigating both directions of sequential associations—the momentary influence of joint engagement on caregiver talk, as well as the momentary influence of caregiver talk on joint engagement—we are able to provide a particularly nuanced illustration of how these two events are intertwined within caregiver-child interactions. More specifically, we can examine whether talk that is considered 'responsive' (i.e., related to what the child is doing) is provided at particular moments within an interaction. Further, we can determine whether particular forms of responsive talk are also 'adaptive'; that is, whether they are likely to elicit continued child activity, such as toy play or joint engagement. Previous research has considered the summary level occurrence of caregiver talk categories that were considered to be responsive, but has not considered the timing of this talk beyond whether it was related to what the child was currently doing. It also has not considered the immediate effects of this talk on caregiver-child interactions. For example, Siller and Sigman (2002; 2008) considered follow-in directives to be out of sync with the child's actions (as they suggested the child do something they were not currently doing), and therefore classified this kind of talk to be unresponsive, which may connote that caregivers should avoid this type of talk. However, there is now evidence that such directives are useful for eliciting child toy play (Bottema-Beutel et al., 2017). This suggests that, whether or not follow-in directives can be considered responsive, they are adaptive to the child's interactional needs. To advance our understanding of these issues, we examined four research questions involving theoretically motivated comparisons between sequential associations calculated for pairs of joint engagement and caregiver talk variables.

First, we examined whether the sequential association between follow-in utterances and HSJE was greater than the sequential association between follow-in utterances and LSJE, and more so for children with TD as compared to ASD. Children may be particularly responsive to talk that is related to their current focus of attention, and may be more likely to enter into higher level engagement than lower level engagement when this type of talk is

provided. Further, TD children may be better equipped to capitalize on caregiver talk for entering into HSJE than children with ASD because children with ASD may be 'stuck' in LSJE as their highest level of engagement due to difficulty in reciprocally engaging with the caregiver during toy play, even when the caregiver provides talk that is relevant to their focus of attention.

Second, we examined whether HSJE was more likely to elicit caregiver follow-in utterances as compared to LSJE, and whether this occurred to a greater degree in dyads that included a child with ASD as compared to dyads that included a TD child. We hypothesized that HSJE may be more likely to elicit follow-in utterances from the caregiver relative to LSJE in the ASD group because caregivers of children with ASD may be more attuned to the necessity of providing their utterances in engagement states where the child seems most likely to attend to them. In contrast, caregivers of TD children may regard their children as able to understand their talk even in states in which the child is not showing particularly high-level joint engagement (i.e., LSJE). Therefore, they would be equally likely to provide follow-in utterances following LSJE and HSJE, which would result in sequential associations being similar across these two different pairs of events.

We also wanted to know whether follow-in utterances were better at eliciting HSJE than utterances that were related to the caregiver's focus of attention, and whether this occurred to a greater extent in children with ASD as compared to TD. Utterances tailored to child interests may be better at prompting higher order engagement than utterances not tailored to child interests, because children will not be required to shift attention to a new object to engage. Children with ASD may be more dependent on talk that is tailored to their interests in this way than TD children because of difficulties disengaging with their current focus of attention to focus on something new (Landry & Bryson, 2004).

Finally, we examined whether caregiver follow-in directives were more likely to elicit HSJE as compared to follow-in comments, and more so for children with ASD as compared to TD. Follow-in directives entail clues to how the child might respond, as well as 'response pressure' that could be fulfilled by following through on the request (Bottema-Beutel, Malloy et al., 2017; Goodwin & Cekaite, 2012; Stivers & Rossano, 2010). In comparison to children with TD, children with ASD may rely more on these aspects of directives to enter into or remain in HSJE, because they may have more difficulty reciprocally engaging during play interactions. Children with TD may easily enter into HSJE, whether or not their caregiver has provided a follow-in directive. This pattern of contingencies would result in stronger sequential associations in the ASD group.

Method

This study used a subset of data from a larger project focusing on language development in children with ASD (Yoder, Watson, & Lambert, 2015). In the ASD group, children had a clinical diagnosis of autism or pervasive developmental delay- not otherwise specified (PDD-NOS). All diagnoses were confirmed via research-reliable administration of the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000). Children with co-morbid conditions were excluded. We also used data collected later from a group of TD

toddlers screened for prior evidence or caregiver suspicion of developmental delay and matched on mental age to the ASD sample. Prior to assessments, caregivers provided informed consent.

Ninety-eight children participated; 50 children with ASD (7 girls) and 48 children with TD (22 girls). For the ASD group, the mean ADOS Algorithm score was 22.19 (*SD* = 4.40). The mean chronological age (CA) was 39.6 months (*SD* = 7.21) in the ASD group, and 14.22 months (*SD* = 4.71) in the TD group. The mean mental age (MA) was 13.54 months (*SD* = 4.33) in the ASD group, and 13.86 months (*SD* = 4.30) in the TD group at study entry. Participants were recruited from the northeastern and southern United States between 2009 and 2015. All reported English as their home language, and the sample was 73% White/Caucasian, 12% Black/African American, 4% Asian, 1% American Indian/Alaska Native, and 6% Mixed Race. For primary caregivers, 31% had a graduate degree, 33% had 3-4 years of college, 16% had 1-2 years of college, 14% had a high school diploma, and 3% did not have a high school diploma.

Assessment Procedures

Parent-child Free Play Session (PCFP)—Children and caregivers were invited to play with a standard set of toys. The set included toys that afforded exploratory, functional, and symbolic play (e.g., nesting blocks, toy knife and fruit, and a doll and bottle). After a brief warm-up period, caregivers and children were asked to play as they normally would. The researcher left the room, offering no further input. The session lasted 15 min, and was video recorded. Caregiver talk and child play behaviors were coded from these videos.

Mullen Scales of Early Learning (MSEL)—The MSEL is a researcher administered test of MA, which is derived by averaging age equivalence scores across four subscales; fine motor, visual perception, receptive language, and expressive language. The MSEL was administered four months prior to the PCFP in the ASD group, due to the study design from which this dataset was drawn. However, the MSEL procedure and PCFP were administered concurrently in the TD group. Because of this difference, two *t*-tests were conducted to determine whether the two groups were adequately matched on MA. The first used MSEL scores from the ASD group without any correction. The second used an 'adjusted MA' to account for growth in the ASD group during the 4 month lag in assessments, calculated as follows: (MA/CA)*4 + MA. This yielded an adjusted MA of 15.06 months for the ASD group. Groups were non-significantly different on MA and adjusted MA; $p = .71$ and .25, respectively.

Coding Procedures

Caregiver talk and joint engagement were coded from PCFP videos using Procoder DV software (Tapp, 2003). Operational definitions and examples of each code are available in Table S.1 in supplementary information. Joint engagement states were coded in two passes using timed event duration recording. The first pass was performed to identify SJE states, and the second pass was performed to differentiate between lower-order and higher-order sub-states. Caregiver talk was coded in a separate data file using a 5 s partial interval coding system. The two data files (i.e., duration data on SJE codes and partial interval data on

caregiver talk) were then combined into a single data file using Procoder Merger (Tapp, 2013), a custom-made software program that converted the SJE sub-state codes from durations to 5-s intervals. If a sub-state code overlapped with any portion of a 5-s interval, that sub-state would be coded as present for the interval. Coders overlapped on 20% of coding files to calculate inter-coder reliability. Two-way random effects models with absolute agreement were used to calculate ICCs for the frequency of intervals for individual codes and for the risk differences computed for each sequence of interest (see below for an explanation of the risk difference). These ICCs are reported in Table 1; all were in the acceptable range.

Statistical Analysis

As in our previous work (e.g., Bottema-Beutel, Malloy, et al., 2017), the *risk difference* was chosen as a metric of sequential association because it provides an adequate quantification of the contingency between two codes while accounting for chance sequencing (Lloyd, Kennedy, & Yoder, 2013). An interval lag-1 method was used to compute the risk difference for each sequence of interest, using code files generated from the PCFP sessions. Adjacent interval pairs from the two simultaneous coding streams (i.e., intervals from one coding stream and the subsequent interval from the other coding stream) were tallied into one of four cells in a 2 × 2 contingency table, depending on the presence or absence of the target codes occurring in the order of interest. See Table 2 for an example 2 × 2 table. Using these cell tallies, the risk difference is computed using the following equation:

$$\text{Risk Difference} = A/(A + B) - C/(C + D)$$

Possible values of the risk difference range from −1 to 1. As applied to the example sequence shown in Table 2, a positive risk difference would indicate that HSJE is more likely to occur immediately following intervals with a follow-in utterance relative to intervals without a follow-in utterance. In other words, a positive risk difference would suggest the occurrence of follow-in utterances increases the momentary probability of HSJE. A negative risk difference would indicate that HSJE is less likely to occur immediately following intervals with a follow-in utterance relative to intervals without a follow-in utterance.

To answer our primary research questions, each of which is related to (a) differences in sequential associations between two different event pairs, (b) group differences in sequential associations for children with ASD and children with TD, and (c) interactions between the different event pairs and group, we used mixed effects models. The risk difference was modeled as the outcome, individual children were modeled as random effects, and group, event pair, and CA were modeled as fixed effects. We chose mixed effects models because they account for the non-independence of code pairs, which were nested in individual children, and do not require the same assumptions as in traditional within-subjects analysis of variance (Wang & Goonewardene, 2004). Because the two groups were significantly different in their chronological age, CA was included as a control variable in each model.

There are two scenarios in which risk difference values are undefined: when tallies for Cells A and B sum to zero (i.e., the first event in the sequence of interest was never coded as present) or when Cells C and D sum to zero (i.e., the first event in the sequence of interest was never coded as absent). One or more undefined risk difference values were identified for three sequences of interest: HSJE→ follow-in utterance (11 undefined values), LSJE→ follow-in utterance (7 undefined values), and follow-in directive→HSJE (2 undefined values). Mixed effects models including these sequences were conducted with undefined values recoded as missing.

Results

Base Rates of Engagement State Variables and Caregiver Talk Variables

The frequency of intervals coded for caregiver talk and for SJE differed by group, indicated by two separate MANOVAs for SJE (F [2, 95] = 3.54, p = .033, Wilks' = .93) and caregiver talk (F [3, 94] = 4.52, p = .005, Wilks' = .87; note that these tests for caregiver utterances have also been reported in Bottema-Beutel et al., 2017). Follow up one-way ANOVAs revealed that there were more intervals with LSJE in the ASD as compared to the TD group, but no differences in the number of intervals of HSJE between groups. There were also more caregiver follow-in comments in the TD group, but there were no group differences between caregiver follow-in directives or caregiver-focused utterances. Descriptive statistics for each code and statistics resulting from ANOVAs are reported in Table 3.

Sequential Associations

Means, ranges, and standard deviations for risk differences can be found in Table 4. For all four of the mixed-effects models described below, CA was not a significant correlate of the sequential associations of interest. To describe the event sequences compared in each model, we use the notation 'Event X → Event Y' to denote the specific codes in each sequence and their ordering.

Results for RQ1, which compared follow-in utterances → HSJE and follow-in utterances → LSJE, are illustrated in Figure 1. Our predictions were not confirmed; there was no difference for group, sequence, or interaction between group and sequence. However, the marginal mean risk differences were positive and significantly different from zero. This indicates that follow-in utterances increased the momentary probability of SJE, regardless of level, in both groups.

Results for RQ2, which compared HSJE → follow-in utterances and LSJE → follow-in utterances, are illustrated in Figure 2. Our predictions were partially confirmed; there was a main effect of group, with higher sequential associations in the ASD as compared to the TD group (Cohen's d = 0.44), regardless of the type of SJE that was considered. Our predictions regarding the main effect of sequence type (which differentiated between LSJE and HSJE) and interaction between group and sequence were not confirmed.

Results for RQ3, which compared follow-in utterances → HSJE and caregiver-focused utterances → HSJE, are illustrated in Figure 3. Our predictions were partially confirmed; there was a main effect of sequence, with the sequential association between follow-in

utterances → HSJE higher than the sequential association between caregiver-focused utterances → HSJE, regardless of group (Cohen's $d = .74$). However, there was no main effect of group, and no interaction between group and sequence.

Finally, Results for RQ4, which compared follow-in directives → HSJE and follow-in comments → HSJE, are illustrated in Figure 4. Our predictions were partially confirmed; there was a main effect of sequence, with higher sequential associations between follow-in directives → HSJE than between follow-in comments → HSJE, regardless of group (Cohen's $d = 0.71$). However, there was no main effect of group, and no interaction between group and sequence. Table 5 displays coefficients, their standard errors, and confidence intervals for each of the 4 mixed effects models.

Discussion

Within the constraints of a correlational design, this study revealed important findings regarding contingencies between caregiver-child joint engagement with toys and different types of caregiver utterances within a play session. First, our findings are consistent with a hypothesis that caregiver follow-in utterances elicit SJE. Second, we showed that the sequential association between SJE and caregiver follow-in utterances was stronger in ASD dyads than in TD dyads, with an effect size approaching the moderate range. Thus, the evidence for the bidirectional effect of SJE and follow-in utterances is stronger in dyads with children who have ASD than in dyads with TD children. In the latter group, evidence suggests a unidirectional effect from adult follow-in utterance to SJE.

The higher sequential associations between SJE and follow-in utterances in the ASD group as compared to the TD group suggest that characteristics of children with ASD (including the difficulty they may have engaging with others) may shape caregiver interaction styles. Specifically, caregivers may learn to provide follow-in utterances that are closely timed to follow moments when they are jointly engaged with their children. This interpretation adds to previous research showing that caregivers may be especially responsive to their children with ASD (Bottema-Beutel, Malloy, et al., 2017), and that it is not necessarily differences in the caregivers themselves that lead to increased responsivity. For example, Meirsschaut, Warreyn, and Royers (2011) conducted a within-family analysis and found that caregivers differentiated their interaction style between their children with and without ASD, and displayed increased responsivity to their ASD children as compared to TD siblings. On the other hand, caregivers of children with ASD are likely to have received early intervention prior to their involvement in this study. It is possible that these caregivers learned specific strategies for interacting with their child through these services.

We also found that, relative to caregiver-focused utterances, follow-in utterances were more facilitative of HSJE, a type of joint engagement in which children with ASD might be particularly likely to process follow-in utterances. The effect size was large, and this pattern was consistent across groups. Children may have an easier time entering into an HSJE state when they are not required to shift their attention to a new toy that they are not currently playing with, as would be required when caregivers provide utterances that are related to their own focus of attention (Adamson et al., 2009; Bloom & Tinker, 2001). Additionally,

when caregivers follow the child's lead and provide a follow-in utterance, they are more likely to be focusing on something that the child finds interesting, which may, in turn, motivate the reciprocal play interactions characteristic of HSJE.

We also detected differences between the two types of follow-in utterances that comprise this category, in terms of their ability to elicit HSJE. Follow-in directives were more likely to immediately elicit HSJE than were follow-in comments, and the effect size for this finding was large. For children who are just developing language, providing directives about the child's attentional focus may be an especially prodigious means of aiding the child in sustaining high-level joint engagement with a caregiver. Directives, which are often characterized by particular syntactic and intonation features, may signal to the child that a next action is required even if they do not know what the specific words mean. When the child responds to an action request, this may jump start joint engagement around toys in which both child and the caregiver are reciprocally involved. This extends previous evidence that follow-in directives are 'adaptive' utterances for continuing interactions (Bottema-Beutel, Malloy, et al., 2017). Further, follow-in directives have been shown to have longer-term, positive impacts on child development (Green, Caplan, & Baker, 2014; Haebig, McDuffie, & Ellis Weismer, 2013); our findings suggest that increased supported joint engagement may be mechanism by which this occurs.

Finally, we were unable to detect differences between HSJE and LSJE, either in terms of the tendency of these engagement states to elicit follow-in utterances from caregivers or in terms of the tendency of follow-in utterances from caregivers to elicit these engagement states. The minimal interactivity of LSJE, which involves the caregiver influencing the child's play, may be sufficient to cue caregivers to provide follow-in utterances. Further, it could be that child characteristics (that were not specifically examined in this study), determine whether the child will engage in HSJE as opposed to LSJE following the provision of caregiver follow-in utterances.

Limitations

Findings from this study should be interpreted in light of some limitations. First, while we used rigorous procedures when calculating and comparing sequential associations, the data are descriptive and can only support, and not confirm, hypothesized causal influences. It is possible that particular contingencies between caregiver utterance type and dyadic engagement state occur due to unmeasured variables co-occurring with or eliciting both. For example, there may be differences in the simultaneous cues that caregivers provide when they issue follow-in directives, such as pointing, giving, or handling the toys that are not provided with follow-in comments. These additional cues, and not the interactive properties of directive language, may account for their superiority in eliciting HSJE (Brigham, Yoder, Jarzynka, & Tapp, 2010). Second, we did not differentiate the timing within the interval that certain caregiver utterance types or dyadic engagement states occur. Other sequential analysis methods, such as those based on timed-event data (Lloyd, Yoder, Tapp, & Staubitz, 2016) may have produced more precise contingency values, thus offering a possible explanation for not confirming certain predictions. Relatedly, we also did not differentiate whether follow-in utterances worked to start an HSJE state, or to help to maintain an SJE

state that was already underway, as it is possible for an SJE state to occur for longer than the 5-s intervals we used in our analysis.

Implications for Intervention Research

The results of this study suggest that it may be beneficial for early intervention programs that focus on joint engagement to encourage caregiver use of follow-in utterances, especially suggestions about how children might play with toys in which they show an interest (i.e., follow-in directives). Future experimental designs could determine whether groups in which caregivers are given training on the provision of follow-in utterances show higher durations of HSJE during intervention sessions than groups in which caregivers are not given such training. Existing research suggests that the timing of caregivers' interactive moves relative to their children's focus of attention is an important component of caregiver-mediated interventions, and directly influences the duration of time children spend jointly engaged with adults (Gulsrud et al., 2016). In addition, both caregiver follow-in utterances and HSJE could then be tested as mediators of the association of treatments on more distal developmental gains, such as language and social-communication. Such indirect effects provide evidence that one mechanism by which treatments affect language and social communication is through the enhancement of caregiver follow-in utterances (a potential active ingredient) or HSJE (a potential mechanism).

Conclusion

This study examined the interplay between caregiver talk and caregiver-child joint engagement within the context of a free play session with toys. Findings illustrate contingencies between these two constructs, differences between different talk-joint engagement sequences, and differences between dyads that include a child with ASD as compared to dyads that include a child with TD. We also uncovered similarities between these two groups of caregiver-child dyads. Most importantly, we found that follow-in utterances and SJE were temporally linked to non-significantly different degrees in both groups. Follow-in utterances—especially directives—appeared to elicit the type of SJE in which children show reciprocity with the caregiver in ways that do not require gaze shifting (e.g., motor imitation, following through on a directive, turn taking), and this finding held for the ASD and TD group. Finally, we are able to provide evidence that caregivers of children with ASD are more responsive than TD caregivers, in terms of their tendency to provide follow-in utterances following instances of high-level caregiver child engagement. If future internally valid intervention research supports the hypothesis that these close temporal links occur because the antecedent elicits the following behavior, then these findings can be used to refine early intervention programming.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research was funded by National Institute for Deafness and other Communication Disorders (NIDCD R01DC006893) and the Argyelan Family Foundation Grant through the Lynch School of Education at Boston

College. We are very grateful to the research staff who assisted on this project (Elizabeth Gardner, Nicole Thompson, Paula McIntyre, Cassandra Newsom, Ariel Schwartz, Tricia Paulley, Kristen Fite, Maura Tourian, Ann Firestine, Lucy Stefani, Olivia Fairchild, Amanda Haskins, Danielle Kopkin, Kathleen Berry, Elizabeth Stringer Keefe, Rebecca Louick, Caitlin Malloy, Ashley Antwi, Chelsey Carroll, and Jessica Barnes), and to the families who participated in this project.

References

Adamson LB, Bakeman R, Deckner DF, Romski M. Joint engagement and the emergence of language in children with autism and Down syndrome. Journal of Autism and Developmental Disorders. 2009; 39:84–96. DOI: 10.1007/s10803-008-0601-7 [PubMed: 18581223]

Bakeman R, Adamson L. Coordinating attention to people and objects in mother-infant and peer-infant interaction. Child Development. 1984; 55:1278–1289. DOI: 10.2307/1129997 [PubMed: 6488956]

Bloom L, Tinker E. The intentionality model and language acquisition: Engagement, effort, and the essential tension in development. Monographs for the Society for Research in Child Development. 2001; 66:vii–91.

Bottema-Beutel K, Malloy C, Lloyd BP, Louick R, Joffe-Nelson L, Watson LR, Yoder PJ. Sequential associations between caregiver talk and child play in autism spectrum disorder and typical development. Child Development. 2017; doi: 10.1111/cdev.12848

Bottema-Beutel K, Yoder PJ, Hochman JM, Watson LR. The role of supported joint engagement and parent utterances in language and social communication development in children with autism spectrum disorder. Journal of Autism and Developmental Disorders. 2014; 44(9):2162–2174. DOI: 10.1007/s10803-014-2092-z [PubMed: 24658867]

Brigham NB, Yoder PJ, Jarzynka MA, Tapp J. The sequential relationship between parent attention cues and sustained attention to objects in young children with autism. Journal of Autism and Developmental Disorders. 2010; 40:200–208. DOI: 10.1007/s10803-009-0848-7 [PubMed: 19685286]

Green S, Caplan B, Baker B. Maternal supportive and interfering control as predictors of adaptive and social development in children with and without developmental delays. Journal of Intellectual Disability Research. 2014; 58:691–703. DOI: 10.1111/jir.12064 [PubMed: 23865770]

Haebig E, McDuffie A, Ellis Weismer S. The contribution of two categories of parent verbal responsiveness to later language for toddlers and preschoolers on the autism spectrum. American Journal of Speech Language Pathology. 2013; 22:57–70. DOI: 10.1044/1058-0360(2012/11-0004) [PubMed: 22878512]

Goodwin MH, Cekaite A. Calibration in directive/response sequences in family interaction. Journal of Pragmatics. 2012; 38:1081–1104. DOI: 10.1016/j.pragma.2012.07.008

Gulsrud AC, Helleman G, Shire S, Kasari C. Isolating active ingredients in a parent-mediated social communication intervention for toddlers with autism spectrum disorder. The Journal of Child Psychology and Psychiatry. 2016; 57(5):606–613. DOI: 10.1111/jcpp.12481 [PubMed: 26525461]

Kasari C, Freeman S, Paparella T. Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. Journal of Child Psychology and Psychiatry. 2006; 47:611–620. DOI: 10.1111/j.1469-7610.2005.01567.x [PubMed: 16712638]

Kasari C, Siller M, Huynh LN, Shih W, Swanson M, Hellemann GS, Sugar CA. Randomized controlled trial of parental responsiveness intervention for toddlers at high risk for autism. Infant Behavior and Development. 2014; 37(4):711–721. DOI: 10.1016/j.infbeh.2014.08.007 [PubMed: 25260191]

Landry R, Bryson SE. Impaired disengagement of attention in young children with autism. The Journal of Child Psychology and Psychiatry. 2004; 45(6):1115–1122. DOI: 10.1111/j.1469-7610.2004.00304.x [PubMed: 15257668]

Lloyd BP, Kennedy CH, Yoder PJ. Quantifying contingent relations from direct observation data: Transitional probability comparisons versus Yule's Q. Journal of Applied Behavior Analysis. 2013; 42:479–497. DOI: 10.1002/jaba.45

Lloyd BP, Yoder PJ, Tapp J, Staubitz JL. The relative accuracy and interpretability of five sequential analysis methods: A simulation study. Behavior Research Methods. 2016; 48:1482–1491. DOI: 10.3758/s13428-015-0661-5 [PubMed: 26487048]

Lord C, Risi S, Lambrecht L, Cook EH Jr, Leventhal BL, DiLavore PC, Rutter M. The Autism Diagnostic Observation Schedule-Generic: A standard measure of social and communication deficits associated with the spectrum of autism. Journal of Autism and Developmental Disorders. 2000; 30:205–223. DOI: 10.1023/A:1005592401947 [PubMed: 11055457]

Meirschaut M, Warreyn P, Roeyers H. What is the impact of autism on mother-child interactions within families with a child with autism spectrum disorder? Autism Research. 2011; 4:358–367. DOI: 10.1002/aur.217 [PubMed: 21882362]

Schreibman L, Dawson G, Stahmer AC, Landa R, Rogers SJ, McGee GG, Halladay A. Naturalistic developmental behavioral interventions: Empirically validated treatments for autism spectrum disorder. Journal of Autism and Developmental Disorders. 2015; 45:2411–2418. DOI: 10.1007/s10803-015-2407-8 [PubMed: 25737021]

Siller M, Sigman M. The behaviors of parents of children with autism predict the subsequent development of their children's communication. Journal of Autism and Developmental Disorders. 2002; 32:77–89. DOI: 10.1023/A:1014884404276 [PubMed: 12058846]

Siller M, Sigman M. Modeling longitudinal change in the language abilities of children with autism: Parent behaviors and child characteristics as predictors of change. Developmental Psychology. 2008; 44:1691–1704. DOI: 10.1037/a0013771 [PubMed: 18999331]

Stivers T, Rossano F. Mobilizing response. Research on Language and Social Interaction. 2010; 43(1): 3–31. DOI: 10.1080/08351810903471258

Tapp, JT. ProcoderDV [Computer software and manual]. 2003. Retrieved from http://procoder.vueinnovations.com/sites/default/files/public/d10/ProcoderDVManual_0.pdf

Tapp, JT. Procoder merger [computer software]. Nashville, TN: Vanderbilt Kennedy Center; 2013.

Wang Z, Goonewardene LA. The use of MIXED models in the analysis of animal experiments with repeated measures data. Canadian Journal of Animal Science. 2004; 84:1–12. DOI: 10.4141/A03-123

Woynaroski T, Yoder PJ, Watson LR. Atypical cross-modal profiles and longitudinal associations between vocabulary scores in initially minimally verbal children with ASD. Autism Research. 2016; 9:301–310. DOI: 10.1002/aur.1516 [PubMed: 26180010]

Woynaroski T, Watson L, Gardner E, Newson CR, Keceli-Kaysili B, Yoder PJ. Early predictors of growth in diversity of key consonants used in communication in initial preverbal children with autism spectrum disorder. Journal of Autism and Developmental Disorders. 2016; 46:1013–1024. DOI: 10.1007/s10803-015-2647-7 [PubMed: 26603885]

Yoder, PJ., Symons, F. Observational measurement of behavior. New York, NY: Springer Publishing; 2010.

Yoder P, Watson LR, Lambert W. Value-added predictors of expressive and receptive language growth in initially nonverbal preschoolers with autism spectrum disorders. Journal of Autism and Developmental Disorders. 2015; 45:1254–1270. DOI: 10.1007/s10803-014-2286-4 [PubMed: 25344152]

Lay Summary

Our findings suggest that caregivers of children with ASD may be particularly adept at timing their talk to follow moments of high-level joint engagement, and that follow-in directives are particularly facilitative of high-level joint engagement. Future intervention work can capitalize on these findings to support high level caregiver-child engagement around toys, which may promote development in children with ASD.

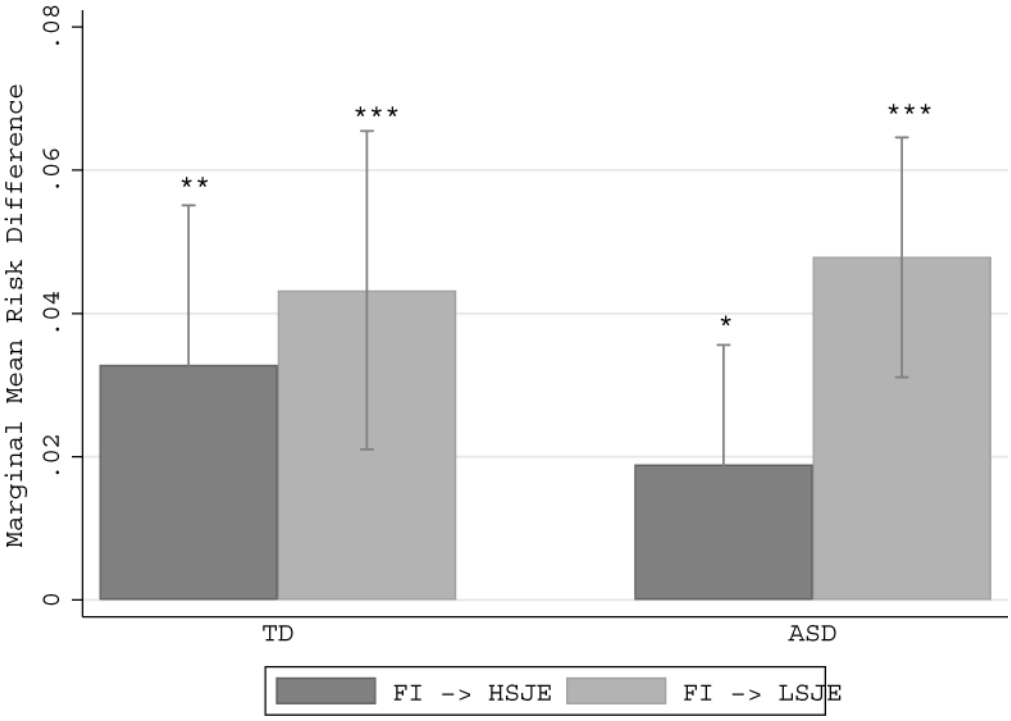

Figure 1.

Marginal mean risk difference for follow-in utterance → HSJE and follow-in utterance → LSJE. Error bars are 95% CIs. Asterisks indicate significant difference from zero, ***$p < .001$, **$p < .01$, *$p < .05$

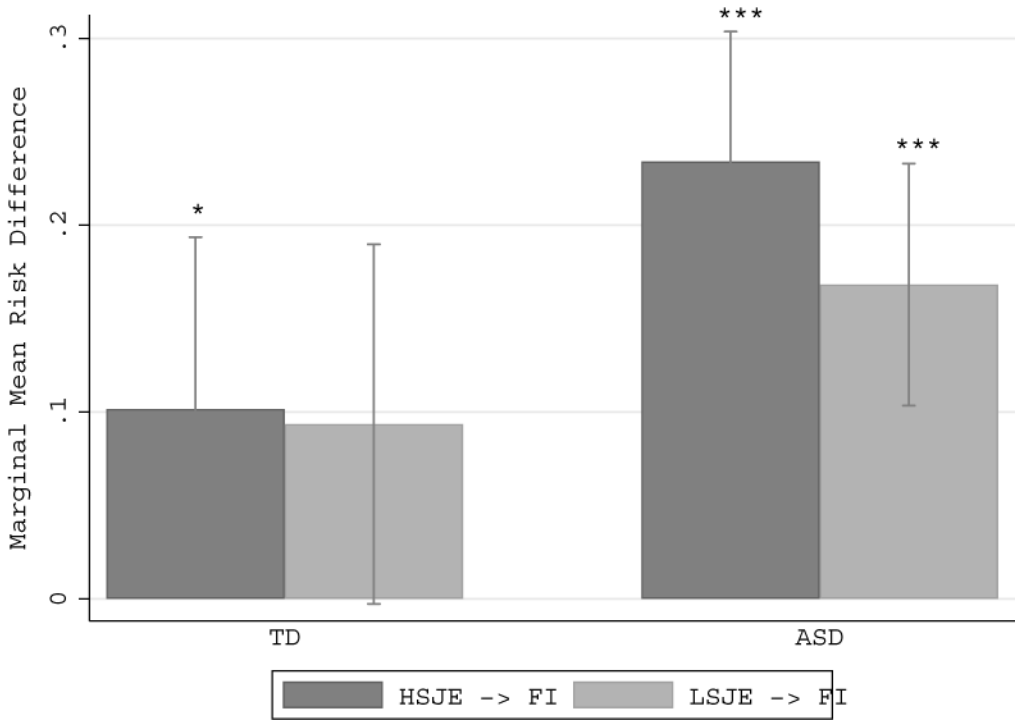

Figure 2.

Marginal mean risk difference for HSJE → follow-in utterance and LSJE → follow-in utterance. Error bars are 95% CIs. Asterisks indicate significant difference from zero, ***$p < .001$, **$p < .01$, *$p < .05$.

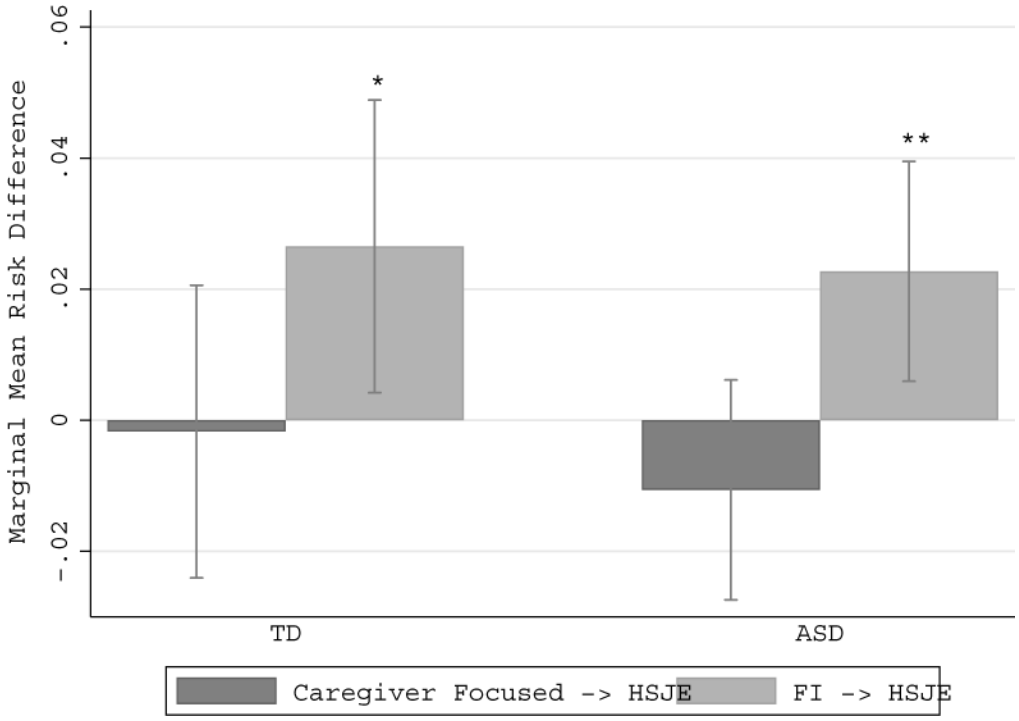

Figure 3.

Marginal mean risk difference for parent-focused utterance→ HSJE and follow-in utterance→ HSJE. Error bars are 95% CIs. Asterisks indicate significant difference from zero, ***$p < .001$, **$p < .01$, *$p < .05$.

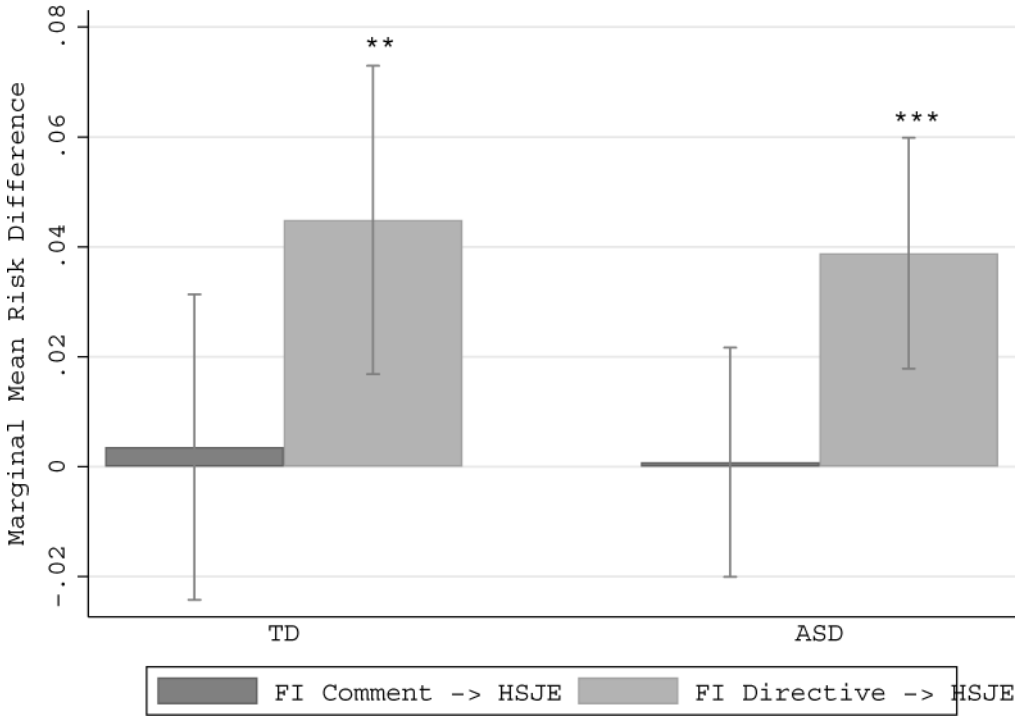

Figure 4.

Marginal mean risk difference for follow-in comments → HSJE and follow-in directives → HSJE. Error bars are 95% CIs. Asterisks indicate significant difference from zero, ***$p < .001$, **$p < .01$, *$p < .05$.

Table 1

Individual Intra-Class Correlation Coefficients from Two-way Random-effects Models, Absolute Agreement

Single Behavior Number of Intervals	**ICC**
HSJE	.87
LSJE	.79
Caregiver-Focused	.74
Total follow-in Utterances	.95
Follow-in Comments	.92
Follow-in Directives	.74
Sequence Risk Difference	ICC
Follow-in Utterance → HSJE	.73
Follow-in Utterance → LSJE	.79
HSJE→ Follow-in Utterance	.97
LSJE→ Follow-in Utterance	.95
Caregiver-Focused Utterance → HSJE	.70
Follow-in Directive → HSJE	.89
Follow-in Comment → HSJE	.77

Note: ICC = Intra-class Correlation Coefficient, LSJE = Lower Order Supported Joint Engagement, HSJE = Higher Order Supported Joint Engagement

Table 2

Contingency Table for Interval Lag-1 Method, for Computing the Sequential Association between FI Utterances→ HSJE

	HSJE is in the Second Interval	HSJE is not in the Second Interval
Follow-in Utterance is in the First Interval	A	B
Follow-in Utterance is not in the First Interval	C	D

Note: HSJE = Higher Order Supported Joint Engagement

Table 3

Summary Statistics and ANOVA Results for Group Differences in Caregiver Talk and Caregiver-child Engagement Variables

	TD		ASD		ANOVA	
	Mean (range)	**SD**	**Mean (range)**	**SD**	**F**	***p***
FI Comments	46.42 (7, 99)	19.60	34.50 (0, 83)	19.92	8.91	0.004
FI Directives	13.16 (0, 32)	8.64	16.50 (0, 40)	9.73	3.24	0.08
Caregiver-Focused	18.50 (1, 62)	11.53	21.60 (0, 51)	12.32	1.66	0.20
HSJE	13.52 (0, 62)	14.05	9.90 (0, 51)	10.46	2.08	0.15
LSJE	9.92 (0, 36)	9.12	15.35 (0, 53)	12.91	5.82	0.02

Note: ASD = Autism Spectrum Disorder, TD = Typical Development, FI = Follow-in, HSJE = Higher order supported joint engagement, LSJE = Lower order supported joint engagement, SD = Standard Deviation

Table 4

Means, Ranges, and Standard Deviations of Risk Differences by Sequence

	TD		ASD	
	Mean (range)	**SD**	**Mean (range)**	**SD**
FI → HSJE	.026 (−.075, .207)	.055	.023 (−.091, .236)	.049
FI→ LSJE	.036 (−.038, .209)	.053	.052 (−.196, .447)	.084
HSJE → FI	.097 (−.311, .593)	.195	.235 (−.359, .822)	.261
LSJE → FI	.087 (−.345, .493)	.226	.173 (−.456, .714)	.253
Comment → HSJE	.003 (−.096, .122)	.042	.001 (−.209, .246)	.066
Directive → HSJE	.044 (−.095, .287)	.104	.039 (−.090, .338)	.091
PF → HSJE	−.002 (−.280, .198)	.010	−.010 (−.126, 1.66)	.052

Note: ASD = Autism Spectrum Disorder, TD = Typical Development, FI = Follow-in, HSJE = Higher order supported joint engagement, LSJE = Lower order supported joint engagement, SD = Standard Deviation

Table 5

Fixed Effects for Risk Differences

RQ1: Follow-in Utterances → HSJE† vs. Follow-in Utterances → LSJE			
	Coefficient	**S.E.**	**95% CI**
Group	−0.14	0.02	[−0.04, 0.02]
Sequence	0.01	0.01	[−0.18, 0.04]
Group × Sequence	0.02	0.02	[−0.02, 0.05]
CA	0.001	0.0004	[−0.002, 0.001]
Constant	0.02	0.01	[−0.01, 0.04]
RQ2: HSJE → Follow-in Utterances† vs. LSJE → Follow-in Utterances			
	Coefficient	S.E.	95% CI
Group*	0.13	0.06	[0.01, 0.26]
Sequence	−0.01	0.06	[−0.12, 0.10]
Group × Sequence	−0.06	0.07	[0.20, 0.08]
CA	0.001	0.002	[−0.003, 0.004]
Constant	0.08	0.05	[−0.01, 0.18]
RQ3: Parent-focused → HSJE† vs. Follow-in Utterances → HSJE			
	Coefficient	S.E.	95% CI
Group	−0.01	0.02	[0.04, 0.02]
Sequence*	0.03	0.01	[−0.0004, 0.06]
Group × Sequence	0.005	0.02	[−0.03, 0.04]
CA	0.00	0.0004	[−0.001, 0.001]
Constant	−0.003	0.01	[−0.03, 0.02]
RQ4: Follow-in Comments → HSJE† vs. Follow-in Directives → HSJE			
	Coefficient	S.E.	95% CI
Group	−0.003	0.02	[-0.04, 0.03]
Sequence *	0.04	0.02	[0.01, 0.08]
Group × Sequence	−0.003	0.02	[−0.05, 0.04]
CA	0.00	0.001	[−0.001, .001]
Constant	0.002	0.02	[−0.03, 0.03]

* $p < .05$

† Sequence serving as the reference group. For all models, the typically developing group is the reference group for the Group variable.

Note: CA = Chronological Age, HSJE = Higher Order Supported Joint Engagement, LSJE = Lower Order Supported Joint Engagement