HHS Public Access
Author manuscript
J Speech Lang Hear Res. Author manuscript; available in PMC 2015 October 01.

Published in final edited form as:
J Speech Lang Hear Res. 2015 April 1; 58(2): 301–310. doi:10.1044/2014_JSLHR-L-13-0257.

Grammatical Aspect Is A Strength in the Language Comprehension of Young Children with Autism

Andrea T. Tovar, **Deborah Fein**, and **Letitia R. Naigles**
Department of Psychology, University of Connecticut, 406 Babbidge Road, Unit 1020, Storrs, Connecticut 06269-1020, Phone: (860) 486-4942, Fax: (860) 486-2760

Letitia R. Naigles: letitia.naigles@uconn.edu

Abstract

Purpose—The comprehension of tense/aspect morphology by children with ASD was assessed via Intermodal Preferential Looking (IPL) to determine whether this population's difficulties with producing these morphemes extended to their comprehension.

Method—Four-year-old participants were assessed twice, four months apart. They viewed a video which presented side-by-side ongoing and completed events paired with familiar verbs with past tense and progressive morphology. Their eye movements were recorded and coded offline; the IPL measures included percentage of looking time at, and latency of first look to, the matching scene. Spontaneous speech samples were also obtained, and coded for number of words, past tense, and progressive inflections.

Results—Relative to their baseline preferences, these four-year-old children with ASD looked more quickly to and longer at the matching scene for both morphemes. Children who produced more words, progressive, and past morphemes, as well as who performed better on standardized language assessments, demonstrated better comprehension of *–ing*.

Conclusion—Overall these children with ASD demonstrated consistent comprehension of grammatical aspect morphology; moreover, their degree of comprehension was found to correlate with spontaneous production and standardized test scores.

Autism Spectrum Disorders (ASD) are characterized by marked impairments in social interaction and communication skills, as well as repetitive and stereotyped behaviors and interests (DSM, IV-TR, APA, 2000). Communicative impairments typically include delays in the onset of language development, as well as difficulties with pragmatic skills such as topic continuation and story-telling (Tager-Flusberg, 2005). The degree to which the lexical and grammatical components of language are also impaired is currently a matter of debate (e.g. Boucher, 2012;Eigsti, Bennetto&Dadlani, 2007; Tek, Mesite, Fein & Naigles, 2013). The current study sheds light on this debate, as it assesses children with ASD's understanding of grammatical aspect using a new method, Intermodal Preferential Looking (IPL; Hirsh-Pasek&Galinkoff, 1996). We also compare their degree of aspect understanding with other measures of their language performance, drawn from standardized tests and spontaneous speech.

Studies focusing on the grammatical abilities of young children with ASD have reported mixed findings. For example, Eigsti, et al., (2007) analyzed the spontaneous speech of 5-

year olds with ASD, and found consistently lower levels of grammatical complexity than matched typically developing(TD) children. Moreover, their production of questions and negation seemed “scattered,” in that more complex forms were sometimes more evident than simpler forms, suggesting that the more complex forms were produced by rote-learning. More recently, Tek, et al., (2013) analyzed the spontaneous speech of 17 children with ASD, from six sessions collected at 4-month intervals between 2 and 4 years of age. The speech was coded for Brown's (1973) 14 grammatical morphemes, as well as for levels of complexity of wh-questions. A high verbal (HV) subgroup (n = 8) demonstrated growth in morphology and wh-questions at the same rate as matched TD controls, whereas a low verbal (LV) subgroup (n = 9) displayed much flatter growth on almost all measures. Children with ASD vary, then, in their levels of grammatical impairment when these are measured via spontaneous speech (Tager-Flusberg, 2005; Boucher, 2012).

Recent studies of language comprehension have revealed a somewhat different picture. Using IPL, Naigles and her colleagues have demonstrated robust comprehension of subject-verbobject (SVO) word order by 2-year-olds with ASD (Swenson, Kelley, Fein & Naigles, 2007), and 3-year-olds with ASD were able to use the SVO frame to learn novel causative verbs (Naigles, Kelty, Jaffery, & Fein, 2011). Moreover, while the comprehension of wh-questions in children with ASD was delayed relative to TD peers, they did demonstrate reliable comprehension by age 54 months (Goodwin, Fein & Naigles, 2012; in press). Interestingly, the children's comprehension of SVO and wh-questions was evident at chronologically earlier sessions than their production of the same constructions. IPL, then, seems to provide an early indicator of language comprehension, possibly because it requires children only to *look* at the scene that matches the linguistic stimuli they hear. For children with ASD, as well as very young TD children, the removal of social (e.g., joint attention) and motor (e.g., pointing) task requirements may enable them to show what they do and do not know about language (cf. Tek at al. (2008) for IPL findings that demonstrate a lack of linguistic knowledge). In the current study, we use IPL to assess children with ASD's understanding of grammatical aspect.

English verbs carry aspectual meaning that refers to distinct periods in time. For instance, the progressive inflection–*ing* expresses the idea that an event is ongoing; it can be affixed to verbs that refer to events that have no inherent end point (e.g. *play*) as well as adjust the meanings of verbs that do (e.g. *build*) (Carr& Johnston, 2001). The contrasting –*ed* suffix expresses the aspectual meaning of completion and thus references events that have an inherent or observed endpoint (e.g. *washed*, *painted*) (Carr& Johnston, 2001). Aspect markers can combine with tense in English, with the –*ed*/irregular past forms conveying both past tense and perfective aspectual meaning while the progressive form can appear in either present (e.g. *she is picking the flowers*) or past (e.g. *she was picking the flowers*) tense (Wagner, Swensen, & Naigles, 2009). Children with ASD's production of English tense and aspect is frequently reported to be impaired. Bartolucci, Pierce &Streiner(1980) reported high omission rates in school-age children, and both –*ed* and –*ing* morphemes showed significantly slower growth in Tek et al.'s (2013) LV group compared to their HV group. Moreover, Roberts and her colleagues (2004) elicited regular and irregular past tense forms from 10-year-old language-impaired (LI) children with ASD and reported high omission rates (23%), with this group performing more poorly than 5-year-old TD controls. Additionally, Seung (2007) reported fewer past tense uses from adults with high functioning autism (HFA) compared to adults with Asperger's Syndrome.

However, it is possible that contextual or pragmatic difficulties characteristic of individuals with ASD may be masking—at least somewhat—their grammatical abilities. For example, less frequent usage of the past tense could be partially attributable to less frequent reference to non-present events overall (Condouris, Meyer &Tager-Flusberg, 2003; Eigsti et al., 2007). Moreover, Seung (2007) found that adults with HFA were less likely to respond to questions that were presented in the past tense, with a past tense verb, and attributed the tense mismatches to a lower sensitivity in HFA to the pragmatic conventions of question-answer discourse. Finally, as Williams, Botting& Boucher (2008) have pointed out, more of the errors produced by the LI-ASD group in Roberts et al. (2004) were errors of using the wrong verb or no response (totaling 38%) rather than using a bare stem; thus, these children might not have fully understood the task, diminishing the number of past tense forms produced. We propose to assess the *comprehension* of grammatical aspect in children with ASD, using the IPL paradigm because it makes few pragmatic or social demands. While the comprehension of grammatical aspect has not been assessed in children with ASD, Wagner et al. (2009) reported that 30-month-old TD toddlers consistently mapped–*ing* onto ongoing events and –*ed*/past inflections onto completed events with both familiar and novel verbs. Therefore, the first purpose of the current study was to extend the Wagner et al. paradigm to children with ASD, who averaged 4 years of age. Successful comprehension in these children with ASD would provide evidence that their difficulties in producing these markers are not wholly grammatical in nature.

Children's language comprehension abilities do not exist in a vacuum, of course,and it is reasonable to ask to what degree the children with more advanced comprehension skills in aparticular domain are also the children with more advanced production skills in that domain, and/orwith better performance on standardized tests of language. Condouris, et al., (2003) have found that lexical measures (i.e., word types) of the spontaneous speech of children with ASD correlated with standardized measures of their receptive vocabulary (i.e., the PPVT). Moreover, TD infants' and toddlers' degree of looking during online tasks of word comprehension or sound discrimination have been found to be indicative of their concurrent or subsequent performance on standardized language measures (Fernald, Perfors&Marchman, 2006; Kuhl, Conboy, Padden, Nelson & Pruitt, 2005). Venker, Eernisse, Saffran, and Ellis Weismer (2013) have recently extended these findings to 5-year-olds with ASD, whose accuracy of looking during a word comprehension task was predicted by their performance on a vocabulary comprehension task conducted three years earlier. Additionally, Naigles and her colleagues (2011) have demonstrated with three-year-olds with ASD that their latency of looking to the match in an SVO comprehension task predicted their accuracy of looking to the match when learning novel verbs in sentences, eight months later. Thus, accuracy and speed of looking to the matching scene in online comprehension tasks have begun to yield reliable 'degree of comprehension' measures for children with ASD. However, the comparisons thus far have been limited, in that only *lexical* online and standardized test measures have been compared. We do not know the degree to which children's online comprehension of *grammar* correlates with their performance on standardized tests, nor the degree to which their production and comprehension of the same morphosyntactic constructs are correlated. The current study breaks new ground in comparing children's IPL measures of language comprehension with concurrent measures of their language *production*.

In sum, we address two questions: (1) Can children with ASD correctly map tense/aspectmorphemes onto their distinct meanings in an IPL paradigm, looking longer at ongoing action when they hear verbs ending in *–ing* and at completed actions when they hear verbs ending in*–ed/past*? To the extent that their difficulties with tense/aspect morphology are grammatically based, children with ASD should have difficulties accurately matching these morphemes with their meanings. However, if their difficulties with tense/aspect morphology include contextual or pragmatic components, then good performance is expected in the IPL task because it makes fewer social, context-specific, or pragmatic demands. (2) To what extent does their comprehension of verb tense/aspect morphemes correlate with their production of these forms, and with standardized assessments of language? Based on previous IPL studies, we expect substantial correlations between the IPL measures and the production and standardized test measures.

Method

This study was part of a longitudinal project in which the children were visited in their homes at 4-month intervals over a period of two years (i.e., 6 visits). Other portions of this study have been published elsewhere (Tek et.al. 2008; Tek et. al. 2013; Naigles et. al. 2011; Goodwin et al., 2012). For the current study, IPL and spontaneous speech data were collected at visits 5 and 6.

Participants

Twenty-two American English speaking children with ASDs were included in the final sample. All were monolingual English learners and were recruited by contacting treatment facilities that offer Applied Behavior Analysis (ABA). These service providers distributed information about the study to parents of children who had been diagnosed within the past six months and who were within the first month of beginning ABA therapy. Parents who were interested in the study returned a letter indicating their interest, along with their contact information. Upon contacting the parents, a phone screening was conducted to determine the child's diagnosis and eligibility for the study. Prior to participation in the study, all parents signed consent forms.

The participants in the group included 15 White males, 3 White females, 2 White/Latinomales, 1 White/Middle Eastern male, and 1 White/Asian male. All children were from middle class orupper-middle-class families living in Connecticut, Massachusetts, New York, or New Jersey. In order to participate in the study, children needed to be receiving 15 to 20 hours of ABA intervention per week to ensure some consistency in the interventions being received. We accepted participants who were diagnosed with either Autistic Disorder or Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) due to the difficulty in drawing distinctions between those disorders.

Table 1 displays the group's standardized test scores from the Vinel and Adaptive Behavior Scales, 2nd Edition (Sparrow, Cicchetti, &Balla, 2005), and the Mullen Scales of Early Learning (MSEL; Mullen, 1995) at the two visits when they viewed the Aspect videos. For diagnostic confirmation purposes, we used the Autism Diagnostic Observation Scale (ADOS-G; Lord et al., 1989); the scores at visit 5 are presented in Table 1. The age-equivalent language scores on the MSEL at visit 6 are similar to the ages of TD children who performed well on the Aspect videos (i.e., 30-36 months; see Wagner et al. 2009).

The children's scores were further scrutinized to ascertain whether any (also) met the usual criteria for specific language impairment (SLI); namely, non-linguistic cognitive scores within the normal range but language scores more than 1.25 SDs below the normal range (Tomblin, Records, Buckwalker, Xuyang, Smith & O’Brien, 1997). Four children in our sample met these criteria, with Mullen *T*-scores for the Visual Receptive subscale above 42 but Mullen Expressive Language*T*-scores below 35; two of the four also had Mullen Receptive Language*T*-scores below 35.

Materials

Standardized test measures—The ADOS-G was administered to assess ASD status. We also administered the Vinel and Adaptive Behavior Scales, 2nd Edition,to evaluate children's communication, socialization, daily living skills, and motor skills, which yielded standard scores based on parents’ reports. The Mullen Scales of Early Learning were administered to measure the development in the areas of visual reception, fine motor skills, receptive language, and expressive language. We present raw scores and age equivalents for all four subscales to illustrate how the participants compare to TD children.

P-IPL apparatus—The Portable Intermodal Preferential Looking (P-IPL) paradigm presented the children with two side-by-side videos, paired with an audio in child directed speech that corresponded to only one of the videos. The stimuli were projected from a laptop via an LCD projector onto a portable 63” × 84” projector screen. The films of the children's eye movements were recorded and then digitized and coded off-line via a custom program (see Naigles & Tovar (2012) for more information).

IPL stimuli and design—The stimuli were the videos used by Wagner etal.(2009, Experiment 1). This video showed two renditions of an event, one ongoing and theother completed. At visit 5, children saw two events: (a) a girl washing vs. having washed a dolly, (b)the girl drawing vs. having drawn a ball. At visit 6, the children saw these plus an additional two events: (c) the girl picking/having picked flowers and (d) the girl drinking/having drunk juice. Each rendition was six seconds long, with three-second long intertrial intervals (ITI) of blackness with a centralized flashing red dot. The layout of the Aspect video included*familiarization* trials, which introduced the ongoing and completed renditions of each event sequentially, one situated on each side of the screen (see Table 2, trials 1 and 2). The audio for these trials simply labeled the girl(e.g. “*Look here, look at her!*”); all audios were presented once during the ITIs and then repeated when the visual stimuli appeared. During the *control trials* (trial 3 in Table 2), the two renditions were played simultaneously; the audio was “Now we see her in both!” These trials revealed the children's baseline looking preferences. The *test trials* showed the two stimuli displayed side by side accompanied by a directing audio. During the first block (two verbs at Visit 5, four verbs at Visit 6), the audio presented the verbs in their past tense forms (e.g. “She washed the dolly”); during the second block, the same verbs were presented with the –*ing*suffix (e.g., “She's washing the dolly”; see Table 2, trial 4).

Procedure

For the IPL tasks, the child was seated 3 feet in front of the screen and camcorder, and watched a series (n = 3) of videos. Children either sat in their parent's lap or by themselves in a small chair. Parents were given an mp3 player with noise-cancelling headphones while watching the videos, to reduce the chances of their influencing their child's gaze during the video presentations. The Aspect video was the second video of the IPL series that the child watched, at both visits.

The ADOS-G (visit 5) and MSEL (visit 6) were administered to the child immediately afterviewing the IPL videos. After these tests, the parent and the child engaged in a 30-minute playsession, half of which was semi-structured [based on the Screening Tool for AutisminTwo-Year-Olds (STAT) protocol; Stone,Coonrod,&Ousley,2000]. For this portion, the parent was periodically handedcards that prompted them to play with particular items that had been provided by the researcher. Forexample, cups were used to build a tower; the child was asked to choose between an empty container and one with a snack in it, and the parent and child looked in a pillow case filled with toys. The prompts facilitated discussion of a variety of topics, while allowing the parent to produce the same quality of speech that he or she normally would in that situation. The final portion of the session was free play. The play session was recorded and later transcribed.

Coding

The children's direction and duration of gaze were coded frame by frame during the control and test trials, measured in hundredths of a second. A trained coder who was blind to stimulus audio marked the child's fixation to the left, right, center, or if the child was not looking at all (away). The children's visual fixations were tabulated and analyzed by a custom program. Trials where the child did not look at the center light for a minimum of 0.3 seconds, and where the child had not looked at either screen (once the events appeared) for a minimum of 0.3 seconds were excluded. These excluded trials comprised fewer than 10% of the total, and averages were calculated without replacement. To assess inter-rater reliability, all videos were re-coded by a second person; the correlation between coders was 0.981 (p< 0.01).

Description of Dependent Variables

Three types of IPL measures were calculated. The first measure is the children'spercent of looking time to the matching scene during the control trials as compared to the test trials. If the children understood the verb inflections, they should look longer at the ongoing renditions upon hearing verb endings with–*ing* suffixes and longer at completed renditions when the audio includes the past tense, relative to their preferences for these renditions when no directing audio is given. The second measure calculates their percent looking time to the *completed* renditions during both audios. Thus, children hearing verbs in the *past* should look *longer* to the completed rendition, but children hearing verbs with *–ing* should look *less* at the completed rendition. This allowed us to investigate whether the different audios led the children to look at different renditions. Our third measure examined the length of time in seconds (latency) for children to make their first look to the matching vs. nonmatching rendition. Children who understand the audio should look more quickly at the matching scene than the nonmatching scene.

The percent looking time measures were then analyzed in three ways. Many IPL studie shave found that children who understand the linguistic audio find the matching scene early in the test trial, especially when, as in our case, the audio is first presented before the visual stimuli appear. Thus, their looking patterns during first half of the trial are considered to indicate their level of comprehension, and their looks away from the match later in the trial are considered to indicate noise, or boredom (Candan, Kuntay, Yeh, Cheung, Wagner & Naigles, 2012; Gertner, Eisengart& Fisher, 2006; Naigles, et al., 2011; Syrett&Lidz, 2010). Other IPL studies have found that children sometimes take longer to find the matching scene, especially with more complex/less well-learned constructions, thus demonstrating significant preferences only during the second halves of trials (Candan et al., 2012; Goodwin et al., in press; Naigles et al., 2011). We had no a priori expectations concerning whether the children in this study would show early vs. later preferences for the match, so we assessed their preferences during the first and second halves of the test trials separately, as well as the entire test trial. The data for each measure were averaged across visits 5 and 6 to provide a more stable indicator of the children's level of comprehension.

Correlation analyses were conducted between two IPL variables, five spontaneous speech variables, and the MSEL standardized test measures. The two IPL measures were the children'spercent looking to the match during the entire test trial and their first look latency to the match, also during the test trial. There were a total of seven spontaneous speech measures extracted from the transcripts, the first three of which included MLU and types and tokens of words. The final two production measures were the number of verb types and tokens that appeared with the progressive marker *–ing*, and the number of verb types and tokens that appeared with the *past tense*markers (both regular and irregular combined). These latter measures provided an indication of how flexible or generalized the progressive and past morphemes were. That is, children might produce many tokens of the progressive and past tense; however, usage with just one or two verbs would be considered to be less advanced—and possibly more context dependent—than usage with a larger set of verbs (Pine, Lieven& Rowland, 1998; Naigles, Hoff &Vear, 2009). MSEL raw scores were used in these correlations because the standard scores had restricted ranges at the lower end of the scale (i.e., a number of children received *T*-scores of 20).

Results

IPL Measures

Table 3 displays the children's scores for their overall percent looking to the matching scene during the control and test trials, as well as their percent looking during the 1st and 2nd halves of the test trials. For all but one of the comparisons, a majority of the children looked longer at the matching scene during the test trials compared with the control trials; this pattern (and so the effect sizes; see Table 3) wasmost robust for the '1st half' measure.

Three two-way repeated measures ANOVA's were performed on the children'spercent looking to the matching scene. The within-group factors were Audio (*past*,*–ing*) and Trial (control, test). For looking time over the entire trial, and looking time for the second half, there were no significant effects or interactions. However, a main effect of trial was obtained for children's percent looking to the match during first half of the test trial [$F(1,21) = 13.21$, $p<.005$, $\eta^2 =.39$], with no other significant effects. Thus, the children looked significantly longer at the matching scene during the first half of the test trial than during the control trial, for both the*–ing* and *past* audios.

Additionally, three two-way repeated measures ANOVAs (entire trial, 1st halfof trial, 2nd half of trial) were conducted with the *percent looking to completed scene* measure. Within-subject factors were Audio(*past*, *–ing*) and Trial (control, test). A main effect of audio was found for the 'first half' measure [$F(1,21) = 8.39$, $p < .05$, $\eta^2 = 0.29$], as well as a significant interaction of audio and trial: [$F(1,21) = 13.21$, $p< .005$, $\eta^2 = 0.39$]. Thus, the children's looking time to the completed rendition varied significantly during the first half of the test trial: when they heard past inflections, they looked *longer* at the completed rendition action during the test trials relative to the control trials whereas when they heard the *–ing* audio they looked away from the completed rendition (see Figure 1). The audio, then, elicited significantly different looking patterns from these children. No significant effects or interactions were obtained with the entire test trial nor with the 2nd half alone.

Finally, a two-way repeated measures ANOVA with the latency variable was conducted, with within-subjects factors of audio (*-ing*, past) and scene (matching vs. non-matching during the test trial). Two main effects were obtained, Audio [$F(1,21) = 10.48$, $p< .05$, partial $\eta^2 = 0.33$] and Scene [$F(1,21) = 16.29$, $p = .001$, partial $\eta^2 = 0.44$]. As shown in Table 3, the children's latency of first look to the match was shorter than their latency of first look to the nonmatch; that is, they quickly identified the matching scene based on the audio they heard in the video. Moreover, they performed more quickly with the *past* audio than with the *–ing* audio.

Analyses including the children's looking patterns only during the trials assessing the regular past (*picked*, *washed*) were also performed; these must be considered exploratory because they include only three trials total. However, they are consistent with the overall *past* findings: The children looked longer at the matching scene during the test trials (*M*s = 62% overall, 69% during the first half, 58% during the second half) compared with the control trial (55%). For both the entire test trial and the 1st half, the differences between control and test were statistically significant ($ts(21) > 2.1$, $ps< .05$).

Correlations between IPL measures and the speech and standardized measures

The means and standard deviations for each spontaneous speech measure are presented in Table 4. The children's mean MLU was 1.96 ($SD = 1.07$).

The correlations between the IPL measures and the spontaneous speech and MSEL measures are presented in Table 5. Children who showed better comprehension of the *–ing* audio (i.e., higher percent looking to the match) also produced more word types and tokens, more tokens of the progressive inflection, more verb tokens of the past tense, and more verb types with the past tense. Moreover, children who looked more quickly to the matching scene when hearing the *–ing* audio (i.e., had shorter latencies to the match) also produced more past tense tokens and more verb types with the past tense.

Children with higher MSEL Receptive Language scores showed better comprehension of the*–ing* audio; they looked more quickly and longer at the matching scene when hearing verbs with the *–ing* inflection. Moreover, children with higher MSEL Visual Reception scores also looked at the matching scene for a longer period of time. However, children's IPL measures did not vary significantly with their ADOS scores.

Scatterplots of three of these relationships are shown in Figure 2; these illustrate the range of production abilities associated with good comprehension of tense/aspect. Figure 2a shows a positive relationship between looking to the ongoing rendition when hearing *–ing* and producing tokens of *–ing*; however, it is also interesting that four children produced very few *–ing* tokens yet looked at the matching scene more than 50% of the time. Figure 2b shows a negative relationship between first look latency to the match when hearing *–ing* and the number of verb types produced with the past tense marker (i.e., children who produced more verb types with this marker were faster to find the match); however, here too, four children produced two or fewer verb types with the past tense marker yet found the matching scene in less than 1.5 seconds. Figure 2c shows a positive relationship between children's understanding of *–ing* and their MSEL RL scores; once more, a couple of children with low scores nonetheless look at the matching scene more than 50% of the time. In sum, while children who were more linguistically advanced generally performed better in the IPL comprehension task, the positive effects seen (longer looking at the match, faster looking to the match) were not solely the province of the high-verbal children. In fact, three of the four children whose Mullen scores were consistent with a specific language impairment followed the pattern of the group as a whole, showing positive comprehension scores for both the *–ing* and past trials.

Discussion

This research investigated the following questions: (1) Would children with ASD demonstrate comprehension of grammatical aspect when examined via IPL? (2) Did the children's understanding of aspect morphemes correlate with their usage of these morphemes in spontaneous speech and/or with their performance on standardized tests? Across two visits, four months apart, the IPL findings indicated that 4-year-old children with ASD looked significantly more quickly at the matching over the non-matching scene when they heard both *–ing* and *past* morphemes, and looked significantly longer at the matching scene for both morphemes, relative to their baseline preferences. This effect held most strongly during the first halves of the test trials; medium to large effect sizes were observed for five of the eight pairwise comparisons (see Table 3). Thus, the children demonstrated comprehension of the *–ing* morphemeas well as the*past*morphemes, in a similar fashion to that of two-and-a-half year-old TD children(Wagner et al., 2009). Moreover, the children's online comprehension of the progressive marker correlated significantly with their production of the –*ing* and *past* morphemes in spontaneous speech, as well as with their performance on standardized tests. As expected, children who used more tense/aspect tokens in spontaneous speech, and with more different verbs, looked more quickly and longer at the ongoing event when hearing the –*ing* audio. Faster and better comprehension of –*ing* also correlated with performance on the receptive language and visual reception subtests of the MSEL.

The children's good comprehension of the –*ing* and pastmorphemes suggests that the omissions of these morphemes that had been previously reported in spontaneous and elicited production studies of children with ASD are not wholly indicative of the children's knowledge. That is, this group of children with ASD, encompassing a wide range of functioning, nonetheless demonstrated a consistent level of understanding such that they could match familiar verbs containing the –*ing* suffix to ongoing renditions of events and the same verbs with the past morpheme to completed renditions of events. Even on an individual level, some children with ASD (at least 4, in our dataset) whose spontaneous speech showed little evidence of these morphemes were able to look longer and more quickly to the matching rendition (Figures 2a, 2b). Moreover, over 60% of children in our dataset looked reliably more at the match during the test relative to control trials (Table 3). And their good performance especially during the first half of the test trials is consistent with the findings of Fernard et al. (2006) and Naigles et al. (2011), indicating that the children found the task to be relatively straightforward and easy.

These findings support the possibility that at least part of the reason why childrenomit these morphemes in production has a contextual or pragmatic basis rather than being solely grammatical. We conjecture, for example, that naturalistic interactions when speech is recorded do not always facilitate usage of the past tense, especially if the focus is on current activities (Condouris et al., 2003; Eigsti et al., 2007); children with ASD may also be less flexible in talking about multiple time frames in the same conversation. Moreover, elicitation tasks may also not be entirely clear to individuals who are challenged in interpreting interactive situations (Seung, 2007; Williams, et al., 2008). Thus, contextual factors join social and motor factors as motivations for including IPL comprehension measures when assessing the language of young children with ASD. Finally, the good performance of these children with ASD raises the possibility that the acquisition of basic tense/aspect morphology is not particularly impaired in autism. We are planning future investigations, within this longitudinal project, of how these children's performance on this IPL-based assessment might be related to their performance, as they get older, on more complex tense/aspect morphology tasks.

While production and comprehension of tense/aspect morphology did not map onto eachother exactly in our dataset, they nonetheless were reliably correlated. Children who looked longer at, and faster to, the ongoing action when hearing verbs ending in –*ing* were the same children who produced more word types and tokens, more tokens of –*ing*, more tokens of the *past* morpheme, and more verb types with the *past* morpheme, in spontaneous speech. These correlations, in addition to the ones with the MSEL, provide additional validation of IPL as providing language measures that capture variability in children's linguistic knowledge. More specifically, these findings extend those of Condouris et al. (2003) to the grammatical domain, providing the first evidence that comprehension and production of specific grammatical components are correlated in young children with ASD. These findings also extend those of Fernald et al., (2006), demonstrating that online measures of grammatical comprehension, in particular, can be shown to be correlated with lexical and grammatical usage in spontaneous speech, as well aswith standardized assessments of language knowledge. It is potentially interesting that the significant correlations were observed with the progressive *–ing* but not with the past tense (see Table 5); however, it is possible that the absence of these latter correlations has its source in the smaller variance of this measure in our dataset (see Table 3). Additional replication is needed.

There are limitations to this study. One of the major requirements for the participantsin our study was that the children be receiving ABA on a regular basis. While this likely reduced the heterogeneity of the sample, we cannot yet say that our findings would generalize to the ASD population as a whole. Moreover, we acknowledge that the past tense audio involved both regular and irregular past tense verbs, and while exploratory analyses suggested that the children performed well on the regular forms, the small number of items precludes our ability in the current study to compare the children's relative ease of understanding the regular vs. irregular forms. The wide range of functioning included in this dataset (see Table 1) might also be considered a limitation; however, we think it is important to have demonstrated that at least some children with ASD who are less verbal in production nonetheless appear to understand components of language that they do not frequently say (see also Swensen et al., 2007; Goodwin et al., 2012).

In sum, we have provided evidence that children with ASD can successfully demonstratecomprehension of the *–ing* suffix and *past* tense suffixes via IPL. Additionally, the children in our study also showed numerous significant correlations between their concurrent language production and overall language levels, and their degree and speed of understanding of the *–ing* morpheme. Given this evidence, as well as the fact that the children were looking longer during the first half of the test trials for both proportion of looking time to the matching scene and the completed scene, we surmise that the children quickly grasped the task at hand and were indeed specifically paying attention to the directing audio.

Intervention for children with ASD often uses pointing or picking up pictures to assess comprehension, with the goal of assessing the success of an intervention program or the child's baseline comprehension level. These results suggest that future research, or assessment practices for individual children, should compare these standard methods of comprehension assessment to IPL. Although good pointing or picking up pictures can confirm comprehension, lack of correct responding is usually taken to mean lack of comprehension, and the IPL results of these and other studies suggest a way of validating this assumption. In addition, IPL might be very helpful in confirming baseline assessments. Learning that individual children have absorbed grammatical forms from hearing natural speech around them, even though they may not respond in a testing situation,will have implications for carefully exposing such children to natural speech with the grammatical forms that are developmentally appropriate for them to grasp.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This research was funded by a National Institute on Deafness and Other Communication Disorders grant to L. Naigles (Grant number: R01 DC007428). We extend our gratitude to Rose Jaffery and Janina Piotroski for assistance in data collection, to Emma Kelty-Stephen for her feedback on data analysis, to the undergraduates of the UConn Child Language Lab for transcribing play sessions and providing assistance throughout the filming of the Intermodal Preferential Looking paradigm, and to Christian Navarro-Torres, Laura Mesite and SaimeTek for parsing many of the children's utterances. We appreciate the helpful feedback we received from attendants of IMFAR 2012 in Toronto and SRCD 2013 in Seattle, WA. Finally, we also thank the children and families who participated in the study.

References

Bartolucci G, Pierce SJ, Streiner K. Cross-Sectional Studies of Grammatical Morphemes in Autistic and Mentally Retarded Children. Journal of Autism and Developmental Disorders. 1980; 10(1):39–49. [PubMed: 6927677]

Boucher J. Research Review: Structural language in autistic spectrum disorder – characteristics and causes. Journal of Child Psychology and Psychiatry. 2012; 53(3):219–233. [PubMed: 22188468]

Brown, R. A First Language: The Early Stages. Cambridge: Harvard University Press; 1973.

Candan A, Küntay A, Yeh Y, Cheung H, Wagner L, Naigles L. Age and language effects in children's processing of word order. Cognitive Development. 2012; 27:205–221.

Carr L, Johnston J. Morphological cues to Verb Meaning. Applied Psycholinguistics. 2001; (22):601–618.

Condouris K, Meyer E, Tager-Flusberg H. The relationship between standardized measures of language and measures of spontaneous speech in children with autism. American Journal of Speech - Language Pathology. 2003; 12(3):349–358. [PubMed: 12971823]

Eigsti IM, Benneto L, Dadlani MB. Beyond Pragmatics: Morphosyntactic Development in Autism. Autism Research. 2007; (37):1007–1023.

Ellis Weismer S, Lord C, Esler A. Early Language Patterns of Toddlers on the Autism Spectrum Compared to Toddlers with Developmental Delay. Journal of Autism and Developmental Disorders. 2010; 40(10):1259–127. [PubMed: 20195735]

Fernald A, Perfors A, Marchman VA. Picking up speed in understanding: speech processing efficiency and vocabulary growth across the 2nd year. Developmental Psychology. 2006; 42(1):98–116. [PubMed: 16420121]

Gertner Y, Fisher C, Eisengart J. Learning words and rules: Abstract knowledge of word order in early sentence comprehension. Psychological Science. 2006; 17(8):684–691. [PubMed: 16913951]

Goodwin A, Fein D, Naigles L. The role of maternal input in the development of *wh*-question comprehension in autism and typical development. The Journal of Child Language. in press.

Goodwin A, Fein D, Naigles L. Comprehension of wh-questions precedes their production in typical development and autism spectrum disorders. Autism Research. 2012; 5:109–123. [PubMed: 22359403]

Hirsh-Pasek, K.; Golinkoff, R. The origins of grammar: Evidence from language comprehension. Cambridge: MIT Press; 1996.

Kjelgaard MM, Tager-Flusberg H. An investigation of language impairment in autism: Implications for genetic subgroups. Language and Cognitive Processes. 2001; 16:287–308. [PubMed: 16703115]

Kuhl PK, Conboy BT, Padden D, Nelson T, Pruitt J. Early speech perception and later language development: Implications for the Critical Period. Language Learning and Development1. 2005:237–264.

Leonard, L. Children with specific language impairment. Second. Cambridge, MA: MIT Press; 2014.

Lord C, Rutter M, Goode S, Heemsbergen J, Jordan H, Mawhood L, Schopler E. Autism Diagnostic Observation Schedule: a standardized observation of communicative and social behavior. Journal of Autism and Developmental Disorders. 1989; 19:185–212. [PubMed: 2745388]

Mullen, EM. Mullen Scales of Early Learning. CirclePines, MN: American Guidance Service; 1995.

Naigles LR, Hoff E, Vear D. Flexibility in early verb use: Evidence from a multiple-n diary study. Monographs for the Society for Research in Child Development. 2009; 74(no. 2)

Naigles L, Kelty E, Jaffery R, Fein D. Abstractness and continuity in the syntactic development of young children with autism. Autism Research. 2011; 4:422–437. [PubMed: 22012625]

Naigles L, Tovar AT. Portable Intermodal Preferential Looking (IPL): Investigating Language Comprehension in Typically Developing Toddlers and Young Children with Autism. Journal of Visualized Experiments. 2012; (70):e4331.10.3791/4331 [PubMed: 23271456]

Pine J, Lieven E, Rowland C. Comparing different models of the development of the English verb category. Linguistics. 1998; 36:807–830.

Roberts JA, Rice ML, Tager-Flusberg H. Tense marking in children with autism. Applied Psycholinguistics. 2004; 25:429–448.

Seung HK. Linguistic characteristics of individuals with high-functioning autism and Asperger syndrome. Clinical Linguistics and Phonetics. 2007; 21:247–259. [PubMed: 17453867]

Sparrow, SS.; Balla, DA.; Cicchetti, DV. Vineland Adaptive Behavior Scales. CirclePines, MN: American Guidance Service, Inc; 1984.

Stone WL, Coonrod EE, Ousley OY. Screening toolfor autism in two-year-olds (STAT): Development and preliminary data. Journal of Autism and Developmental Disorders. 2000; 30:607–612. [PubMed: 11261472]

Swensen L, Kelley E, Fein D, Naigles L. Processes of Language Acquisition in Children with Autism: Evidence from Preferential Looking. Journal of Child Development. 2007; 78(2):542–557.

Syrett K, Lidz J. 30-month-olds use the distribution and meaning of adverbs to interpret novel adjectives. Language Learning and Development. 2010; 6:258–282.

Tek S, Mesite L, Fein D, Naigles L. Longitudinal Analyses of Expressive Language Development Reveal Two Distinct Language Profiles among Young Children with Autism Spectrum Disorders. Journal of Autism and Developmental Disorders. 201310.1007/s10803-013-1853-4

Tek S, Jaffery G, Fein D, Naigles L. Do Children with Autism Spectrum Disorders Show a Shape Bias in Word Learning? Autism Research. 2008; 1:208–222. [PubMed: 19360671]

Tomblin JB, Records NL, Buckwalter P, Xuyang Z, Smith E, O'Brien M. Prevalence of specific language impairment in kindergarten children. Journal of Speech, Language, & Hearing Research. 1997; 40:1245–1260.

Venker C, Eernisse E, Saffran J, Ellis Weismer S. Individual Differences in Real-Time Comprehension of Children with ASD. Autism Research. 201310.1002/aur.1304

Wagner L, Swensen L, Naigles L. Children's Early Productivity with Verbal Morphology. Cognitive Development. 2009; 24:223–239.

Williams D, Botting N, Boucher J. Language in autism and specific language impairment: Where are the links? Psychological Bulletin. 2008; 134:944–963. [PubMed: 18954162]

Wynn J, Smith T. Generalization between receptive and expressive language in young children with autism. Behavioral Interventions. 2003; 18:245–266.

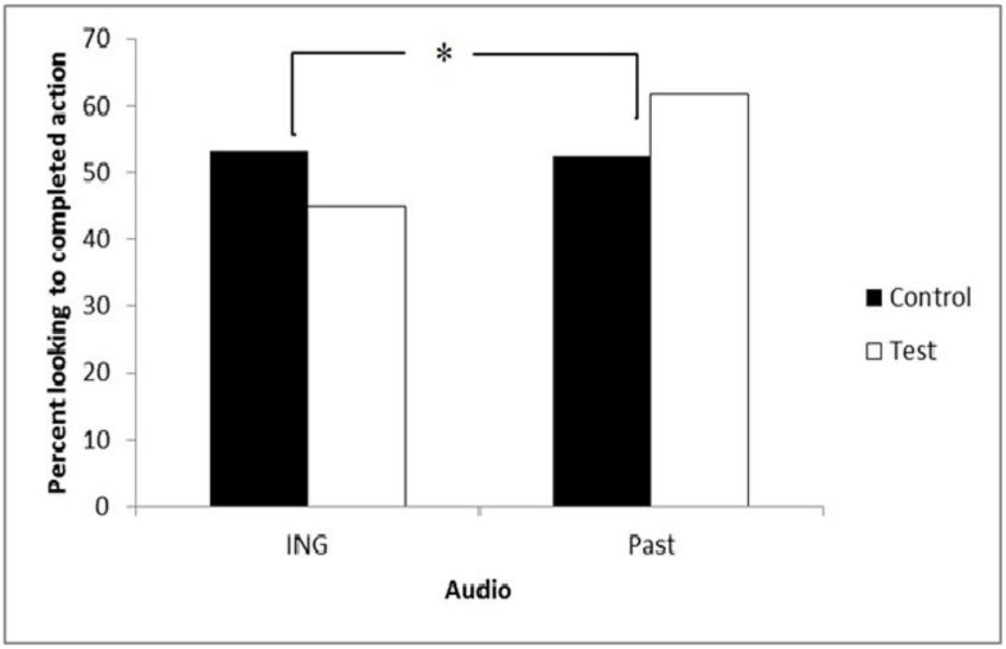

Figure 1.

Percentage of looking time spent on the completed actions during the control trials compared with the first half of the test trials, *$p < 0.05$

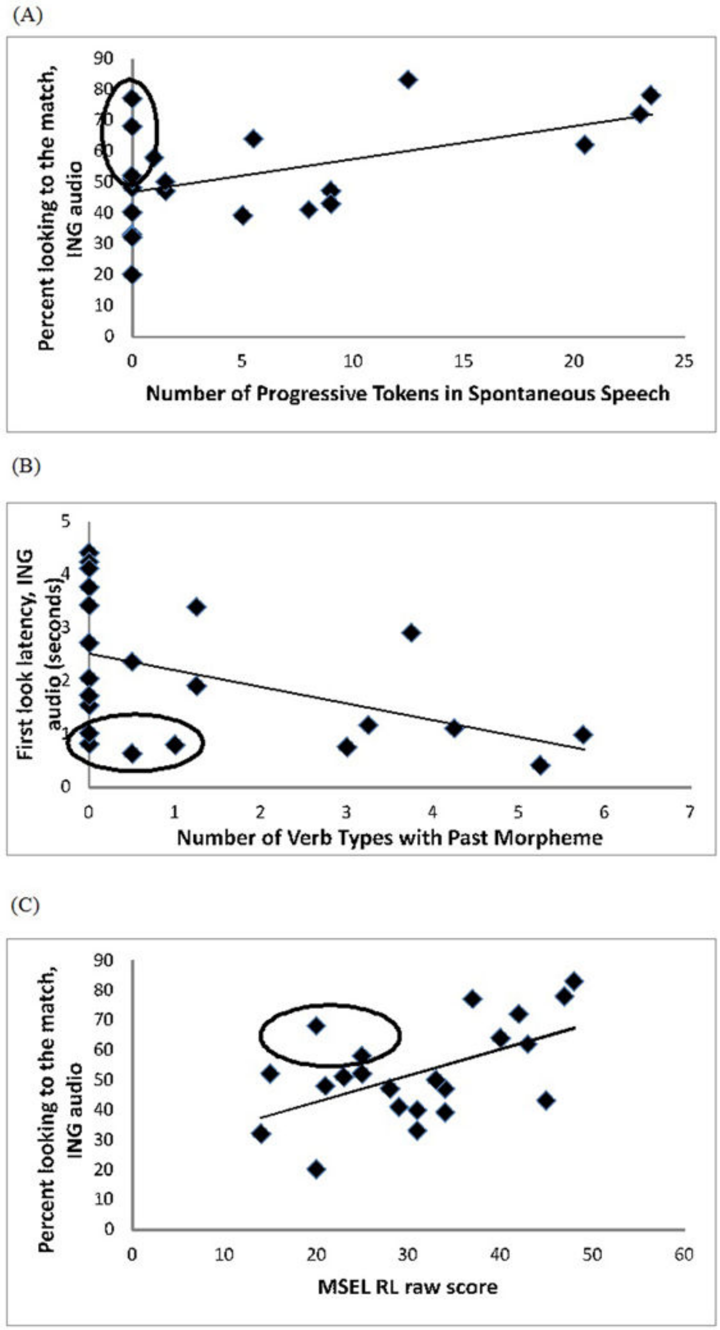

Figure 2.

Scatterplots of significant relationships between (a) children's percent looking time to the match during the test trials for the –*ing* audio and their production of tokens of the progressive morpheme, (b) children's latency of first look to the match during the test trial of the –*ing* audio and the number of different verbs with which they produced the past morpheme, and (c) children's percent looking time to the match during the test trials for the –*ing* audio and their raw scores on the Receptive Language subtest of the MSEL.

Table 1

Demographic and Standardized Test Information from Visits 5 and 6

Visit 5	Mean	(SD)
Age (Months)	49.56	(4.22)
Autism Diagnostic Observation Schedule (ADOS)	14.23	(6.30)
ADOS range	4-25	
Vineland Adaptive Behavior Scales[a]		
Communication	78.91	(21.27)
Daily Living Skills	73.95	(18.52)
Socialization	74.27	(15.72)
Motor Skills	82.41	(17.99)
Visit 6		
Age (Months)	53.92	(4.36)
Vineland Adaptive Behavior Scales[a]		
Communication	85.14	(17.24)
Daily Living Skills	76.59	(14.64)
Socialization	74.82	(12.07)
Motor Skills	85.50	(12.86)
Mullen Scales of Early Learning[b]		
Visual Reception	37.18	(19.14)
Fine Motor Skills	30.23	(16.47)
Receptive Language	32.95	(18.02)
Expressive Language	30.27	(15.25)
Mullen Scales of Early Learning[c]		
Visual Reception	42.73	(15.19)
Fine Motor Skills	36.00	(13.06)
Receptive Language	36.05	(16.44)
Expressive Language	31.95	(17.46)

[a] Standard scores, based on a mean = 100 (*SD* = 15)

[b] T-scores, based on a mean = 50.0 (*SD* = 10)

[c] Age-equivalent scores (months)

Table 2

Partial layout of the Aspect video

Trial	Left Video	Audio	Right Video
1	Girl washing doll	Look here, look at her!	Blank
ITI	Blank	Oh Wow!	Blank
2	Blank	Look here, look at her now!	Girl completes washing dolly
ITI	Blank	Oh Wow!	Blank
3	Girl washing dolly	Now we see her in both!	Girl completes washing dolly
ITI	Blank	***Look, she's washing the dolly!***	Blank
4	**Girl washing dolly**	***Look where she's washing the dolly!***	Girl completes washing dolly

Table 3

IPL Results (Mean, SD)

Percent looking to matching scene	Trial type Control	Test	*N*[a]	Cohen's*d*[b]
ING Entire trial	46.73 (13.15)	52.59 (16.27)	16	.40
ING First half of test trial		55.05 (24.09)	14	.43
ING Second half of test trial		50.36 (20.13)	12	.21
PAST Entire trial	52.50 (8.73)	55.45 (11.18)	13	.29
PAST First half of test trial		61.59 (13.99)	18	.78
PAST Second half of test trial		52.23 (20.48)	10	.02
Latency of first look	Matching	Non-matching	*N*[c]	Cohen's *d*[dc]
ING	2.09 (1.31)	2.73 (1.45)	14	.46
PAST	1.26 (0.89)	1.89 (1.13)	15	.62

[a]Number of children who looked longer at the match during the test trials compared with the control trials

[b]Cohen's *d* based on control (entire trial) vs. test (entire trial, 1st half of trial, 2nd half of trial) comparisons

[c]Number of children who looked more quickly at the matching vs. nonmatching scene

[d]Cohen's *d* based on matching vs. non-matching scene comparisons

Author Manuscript

Author Manuscript

Author Manuscript

Table 4
Spontaneous Speech Types and Tokens – Means and SDs

	Types		Tokens	
	M	**(SD)**	**M**	**(SD)**
Words	98.20	(80.96)	361.75	(346.71)
Progressive inflections	3.11[a]	(4.04)	5.45	(7.84)
Past inflections	2.70[b]	(3.82)	4.23	(6.46)

[a]Number of different verbs produced with the progressive inflection at least once

[b]Number of different verbs produced with the regular or irregular past inflection at least once

Table 5
Pairwise correlations of IPL measures with Speech and Standardized test measures

N = 22

	Percent Looking to Matching Scene[a]		*Latency of First Look to Matching Scene (seconds)*	
Spontaneous Speech (Visits 5 & 6)	**ING Test Trials**	**Past Test Trials**	**ING Test Trials**	**Past Test Trials**
1. MLU	0.379	-0.095	-0.210	-0.079
2. Total Words (Types)	0.443*	-0.195	-0.299	-0.024
3. Total Words (Tokens)	0.426*	-0.141	-0.345	-0.067
4. Progressive Verbs (Types)	0.421	-0.225	-0.385	-0.164
5. Progressive Verbs (Tokens)	0.513*	-0.184	-0.408	-0.109
6. Past Verbs (Types)	0.474*	-0.140	-0.458*	-0.038
7. Past Verbs (Tokens)	0.515*	-0.078	-0.465*	-0.005
Mullen Scales of Early Learning –Raw Scores - Visit 6				
8. Visual Reception Scale	0.436*	-0.181	-0.233	-0.238
9. Fine Motor Scale	0.323	0.024	-0.279	-0.183
10. Receptive Language Scale	0.551**	-0.072	-0.470*	-0.284
11. Expressive Language Scale	0.393	-0.037	-0.279	-0.177
12. ADOS visit 5	-0.290	0.294	0.331	0.017

[a] = Across entire test trial

* $p<.05$

** $p< .01$