The Role of Function Words and Prosody for Phrasal Parsing in Preverbal Infants

Mireille Babineau, Rushen Shi and Andréane Melançon

Abstract

We examined whether infants use function words for phrasal parsing and how functors and prosody interact for parsing. In a preferential looking procedure French-learning 8- and 11-month-olds were familiarized with sentences with the subject-NP+VP structure. The VP began with a functor (*va*, "will") in half of the sentences (e.g., *[Le niveau imposant] va gâcher l'enquête des jeunes*. – "The imposing level will waste the survey of the young ones.") and a nonsense-functor (*ko*) in the other half of the sentences (*[Un produit imposant] ko cibler l'usage du client.* – "The imposing product ko target the use of the client."). In Experiment 1, the subject-NPs contained phrase-final prosodic cues. Infants were tested with the subject-NP spliced from the *va* versus the subject-NP from the *ko* sentences. In Experiment 2 we re-created the familiarization sentences by removing all phrase-final prosodic cues of the subject-NPs using cross-splicing, i.e., the subject-NPs ended with phrase-internal prosody. Infants were tested with the subject-NPs spliced from the *va* versus *ko* sentences of this experiment. Results showed that infants were able to use the functor to assist their parsing of the subject-NP by 11 months of age. Furthermore, 11-month-olds' use of the functor for phrasal parsing was more efficient when phrase-final prosodic cues were also present than when the prosodic cues were absent. The findings demonstrate that functors and prosody are both useful for bootstrapping initial syntactic learning in preverbal infants.

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1. Introduction

Infants have acute abilities to perceive prosodic properties in human languages from the earliest stage of life. Newborns are sensitive to the rhythmic properties of languages and have the ability to discriminate languages based on such prosodic cues (e.g., Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, & Amiel-Tison, 1988; Nazzi, Bertoncini, & Mehler, 1998). This initial sensitivity to prosodic cues develops further during the first year of life and enables infants to find clausal boundaries, as shown in perceptual experiments (e.g., Nazzi, Kemler Nelson, Jusczyk, & Jusczyk, 2000; Seidl, 2007; Seidl & Cristià, 2008). For example, in Nazzi et al. (2000), after being familiarized with two prosodic versions (one 'well-formed' as a clause, and another 'ill-formed' because the word sequence belonged to two separate clauses) of a sequence (e.g., *Leafy vegetables taste so good.* and *leafy vegetables. # Taste so good*) in passages, six-month-old infants preferred to listen to passages containing the prosodically well-formed sequence, suggesting that they used prosodic cues to encode and remember clauses as cohesive units. With the same stimuli, Seidl and Cristià (2008) showed that younger babies (i.e., 4-month-olds) were also able to discriminate clauses and non-clauses, as long as all the supporting prosodic cues (i.e., pitch, pause and pre-boundary length) were present for the clauses. Furthermore, Soderstrom, Seidl, Kemler Nelson and Jusczyk (2003) showed that 6- and 9-month-olds are sensitive to prosodic markers of syntactic units smaller than the clause. In their study infants were familiarized with word sequences such as *design telephones* ("[*design telephones*]" as a phrasal unit, and "*design*] # [*telephones*" as a non-unit), and they listened longer during the test phase when the sequence formed a phrasal unit in passages (such as in *Inventive people* [*design*

telephones] *at home*) than when a phrasal boundary separated the words in the sequence (such as in *The director of design*] # [*telephones at home …*). Thus, early in life, infants can use prosodic cues for the segmentation of running speech into syntactically relevant groupings such as clauses and phrases.

Another potential cue that might assist segmentation and syntactic learning is functional items. Functional items are words or affixes (e.g., determiners, auxiliaries, tense endings, etc.) that primarily serve grammatical roles in phrases and sentences. Relative to content words (i.e., nouns, verbs, adjectives, and adverbs), functors are a small set in any language, but occur highly frequently. Functors tend to occur at the edges of syntactic constituents in input speech (e.g., Shi, Morgan, & Allopenna, 1998). In other words, they are frequent items that may occur at the beginning or at the end of phrasal units, depending on the syntactic characteristics of the language. As with prosodic cues, infants have been shown to be sensitive to functors early in life. Newborns aged 1 to 3 days can categorize function words versus content words by using their distinct phonological and acoustical cues (Shi, Werker, & Morgan, 1999). From about six months of age infants begin to segment, store and recognize function words (e.g., Hallé, Durant, & de Boysson-Bardies, 2008; Höhle & Weissenborn, 2003; Shi & Lepage, 2008; Shi, Marquis, & Gauthier, 2006; Shi, Werker, & Cutler, 2006) and even bound functional morphemes (Marquis & Shi, 2012) in their native language. In Höhle and Weissenborn (2003), German-learning 8-month-olds segmented German function words from longer utterances. French-learning 6-month-olds yielded the same results (Shi, Marquis, & Gauthier, 2006). In Shi and Lepage (2008), French-learning 8-month-olds recognized frequent functors in French such as *des* (i.e., indefinite plural determiner) over the

nonsense syllable *kes*, showing that infants at this age not only recognize frequent functors of their native language, but also store the specific phonetic details in their representation of individual function words. Shortly after one year of age, infants start to form different classes of functors (Shi & Melançon, 2010), such as determiners. At 20 months, they can divide determiners into sub-classes of grammatical genders, e.g., masculine determiners versus feminine determiners in French (Cyr & Shi, 2013).

Furthermore, previous studies suggest that infants' representation of functors assists their learning of syntactic structures such as grammatical categorization of content words. Indeed, in perceptual experiments using novel content words in the context of frequent function words (e.g., Höhle, Weissenborn, Kiefer, Schulz, & Schmitz, 2004; Mintz, 2006; Shi & Melançon, 2010), infants between 1- and 1.5 years of age used function words of their native language to categorize the novel words (for example, as nouns). Infants at this age can even use functor-like items in an artificial language (Gómez & Lakusta, 2004) and in a foreign language (Gerken, Wilson, & Lewis, 2005) to categorize content-word-like items, after a brief training session. Based on these results, it is plausible that infants at an even younger age might use functional items to perform rudimentary analyses of the speech input before they use them for grammatical categorization. In Gervain, Nespor, Mazuka, Horie, and Mehler (2008), 8-month-olds were trained with an artificial language containing continuous streams of nonsense syllables, some appearing frequently and others infrequently. Infants were tested with four-syllabic strings with a frequent-initial syllable versus with a frequent-ending syllable, simulating functor-initial versus functor-final phrases. Italian infants preferred the frequent-initial grouping while Japanese infants preferred the frequent-final grouping,

consistent with the order of their respective native languages. Although the possibility remains that infants processed each four-syllabic string as a lexical unit rather than a syntactic unit, it is reasonable to interpret that they perceived the frequent artificial syllables as functor-like 'words' and used them for phrase-like groupings. In the present study, we directly tested whether preverbal infants use their native language function words to parse continuous speech streams into phrases.

Based on the prosody-functor bootstrapping model (e.g., Christophe, Milotte, Bernal, & Lidz, 2008; Shi, 2014), prosody may work with functional elements to bootstrap syntactic learning. Therefore, our study was aimed at examining 1) whether preverbal infants use function words to parse phrases, and 2) how functors and prosody might interact in infants' phrasal grouping. To address these questions, we designed two experiments. In Experiment 1, functors and phrase-final prosody coincided at the subject-NP (noun phrase) boundary. In Experiment 2, only functors appeared after the subject-NP boundary, and the stimuli were edited such that phrase-internal prosody appeared at the end of the NP. The misleading prosodic cues could potentially impede the parsing of the subject-NP. Experiment 2 thus allowed us to test whether infants could use function words to parse phrases despite the conflicting prosodic information.

2. Experiment 1

2.1.1. Participants and Stimuli

Participants were monolingual Quebec-French-learning infants aged 8 months and 11 months. Familiarization stimuli were two types of sentences with a subject-NP+VP structure, one type with a VP starting with a frequent functor (*va* "will") and the other

type with a VP starting with a prosodically matched nonsense syllable (*ko*). The sentences contained infrequent content words (see Table 1). The NPs contained a determiner, a noun, and a post-nominal adjective *imposant*, which was present for both types of sentences. A female native speaker of Quebec French recorded multiple tokens of the sentences. The recording was done in an IAC acoustic chamber.

Table 1. Sentences for sound recording before and after cross-splicing

Rec. 1	**[Le niveau imposant]** va sauver l'entente des cours. "The imposing level will save the agreement of classes."
Rec. 2	[Le niveau imposant] **va gâcher l'enquête des jeunes.** "The imposing level will waste the survey of the young ones."
Cross-spliced	**[Le niveau imposant] va gâcher l'enquête des jeunes.**
Rec. 3	**[Un produit imposant]** ko sauver l'entente des cours. "The imposing product ko save the agreement of classes."
Rec. 4	[Un produit imposant] **ko cibler l'usage du client.** "The imposing product ko target the use of the client."
Cross-spliced	**[Un produit imposant] ko cibler l'usage du client.**
Rec. 5	**[Le niveau imposant]** ko sauver l'entente des cours. "The imposing level ko save the agreement of classes."
Rec. 6	[Le niveau imposant] **ko cibler l'usage du client.** "The imposing level ko target the use of the client."
Cross-spliced	**[Le niveau imposant] ko cibler l'usage du client.**
Rec. 7	**[Un produit imposant]** va sauver l'entente des cours. "The imposing product will save the agreement of classes."
Rec. 8	[Un produit imposant] **va gâcher l'enquête des jeunes.** "The imposing product will waste the survey of the young ones."
Cross-spliced	**[Un produit imposant] va gâcher l'enquête des jeunes.**

The subject-NPs contained naturally produced phrase-final prosody. Since the subject-NPs in Experiment 2 were cross-spliced, we also did cross-splicing for the stimuli of Experiment 1. The subject-NPs of Experiment 1 were from other sentences, and were intended to be complete NPs. The cross-splicing was done within Praat (version 5.3.04). For each subject-NP, we placed the cutting point in the original recorded sentence at the end of the pause after the word *imposant.* The VP portion was cut out from another sentence starting with *va* or *ko* (the beginning of the /k/ burst). Thus, each newly created sentence was made from a NP of one sentence and a VP from another sentence and

formed a continuous waveform. As shown in Table 1, the bold portion of the original recordings was conjoined to form each stimulus sentence.

Test stimuli were the spliced subject-NPs that were used to form the familiarization stimuli. Auditory stimuli also included a female voice producing the word *Wow*, which was used for the pre-trial. The visual stimulus for the pre-trial was a video of moving balls. The stimuli for the attention-getter were an animation of a moving star and the sound of a cricket. An animation of a bird was created for the familiarization and test trials. Its mouth was manipulated to move synchronously with the speech stimuli.

2.1.2. Procedure

The experiment was conducted in a visual preferential procedure. Infants were individually tested in a sound-attenuated acoustic chamber. Loudspeakers, which were placed together with a central display monitor, presented the auditory stimuli. The monitor in front of the parent and the infant presented the visual stimuli. The parent sat with the infant on his or her lap and wore headphones to hear masking music. The Habit program (Cohen, Atkinson, & Chaput, 2000) was used to run the experiment, which advanced automatically to the test phase after the familiarization phase was completed.

In an adjacent room, a researcher blind to the audio-visual materials observed the infant's eye movement through a closed circuit TV. Every trial was initiated when the infant looked toward the monitor. Once the maximum trial length was reached, the trial terminated automatically. Another researcher blind to the materials coded offline the videos of the experimental sessions. Infants' eye fixations to the central screen were coded frame by frame (30 frames per second).

Each familiarization and test trial presented the animation of the bird, who 'spoke' the speech stimuli. The experiment started with a pre-trial presenting the voice of a woman saying *Wow* with a video of moving balls. The pre-trial served to acquaint the infant to the procedure. The video of the moving star with sounds of the cricket served as the attention-getter between trials to attract infants' attention back to the screen for the next trial.

2.1.3. Design and predictions

The experiment consisted of a familiarization phase and a test phase (Table 2). Two groups of infants were each familiarized with two exemplars of a sentence containing a VP starting with the functor *va,* and with two exemplars of a sentence containing a VP starting with the prosodically matched nonsense syllable *ko* (Table 2). The specific NPs that co-occurred with *va* or *ko* were counterbalanced across groups. During the test phase all infants heard the spliced subject-NP from the *va* sentence and the spliced subject-NP from the *ko* sentence, in alternating trials. Therefore, one test trial type was an NP from the "functor" context, and the other was an NP from the "nonce functor" context. For infants in Group 1, the test trials presenting the NP *le niveau imposant* were from the "functor" context, and those presenting the NP *un produit imposant* were from the "nonce functor" context. The reverse was the case for Group 2: the test trials presenting *un produit imposant* were from the "functor" context, and those presenting *le niveau imposant* were from the "nonce functor" context. The test phase presented two blocks of four trials each and began with either NP (i.e., *un produit imposant* or *le niveau imposant*), counter-balanced across infants.

Familiarization trials had an average length of 8.02 seconds. In each familiarization trial, the two exemplars (average of 3.38 seconds) of one type of sentence (*va* or *ko*) were presented with an inter-sentence silence of 758 milliseconds. In each test trial, an NP was repeated five times, with the two exemplars of the NP presented alternatively. Every test trial lasted 11.26 seconds in total, with an average inter-sentence silence of 1 second.

In the familiarization phase, prosodic cues were present in all sentences. However, one type of sentence included a frequent functor (*va*) and the other a nonce functor (*ko*). Thus, we predicted that if the phrase-final prosody and functor conjointly assisted phrasal parsing and yielded a better processing, infants should discriminate between the NP from the functor context and the NP from the nonce functor context.

The use of the same post-nominal adjective *imposant* for the subject-NPs from both the functor context and the nonce functor context ensured that the experiment indeed tested whether infants segmented the whole subject-NP, rather than just segmenting the last word preceding *va* versus *ko*. This assumption was based on the previous literature showing that infants below one year of age cannot segment utterance-medial vowel-initial words (e.g., Seidl & Johnson, 2008). Moreover, tri-syllabic vowel-initial words should be particularly difficult to segment. This manipulation allowed us to unambiguously assess phrasal parsing.

Table 2. Stimuli and design for Experiment 1.

Group 1 **Familiarization**	**Group 2** **Familiarization**
[Le niveau imposant] ***va*** *gâcher l'enquête des jeunes.*	*[Le niveau imposant]* ***ko*** *cibler l'usage du client.*
[Un produit imposant] ***ko*** *cibler l'usage du client.*	*[Un produit imposant]* ***va*** *gâcher l'enquête des jeunes.*
Test trials: *Le niveau imposant* (functor context) versus *Un produit imposant* **(**nonce functor context**)**	**Test trials:** *Le niveau imposant* (nonce functor context) versus *Un produit imposant* **(**functor context**)**

2.2. Results

Looking times for the two test trial types (NPs sliced from "functor" context versus from "nonce functor" context) were analyzed in paired *t*-tests. Eight-month-olds and 11-month-olds showed similar looking times for all trials while listening to the NPs from the functor *va* context and the NPs from the nonce functor *ko* context, 8-month-olds: $t(15) = -1.674$, $p = .115$; 11-month-olds: $t(15) = 0.771$, $p = .453$. Further analyses compared looking times in the first and the second block of the trials, considering that an effect may appear early or late in the test phase depending on infants' processing speed (see Vihman et al., 2004; Shi, Werker, & Cutler, 2006). As shown in Figure 1, no significant differences were found in either block for the 8-month-olds, first block: $t(15) = -1.308$, $p = .211$; second block: $t(15) = -1.376$, $p = .189$.

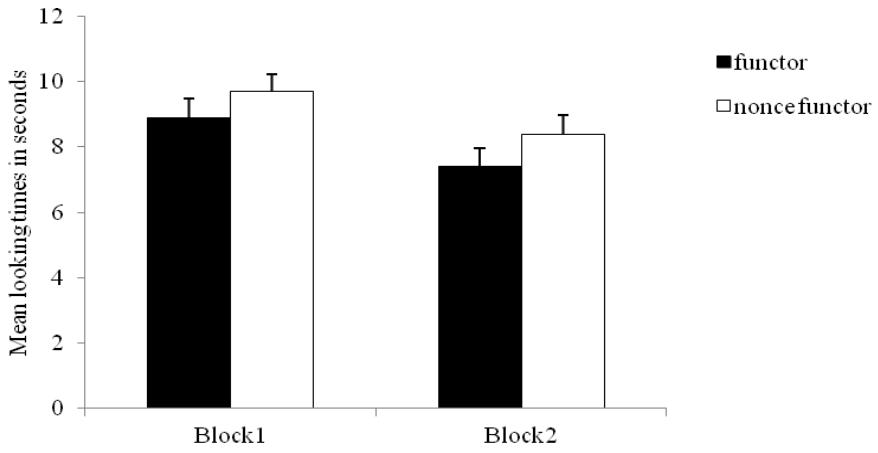

Figure 1. Eight-month-olds' looking (listening) times to the two types of test trials, functor context versus nonce functor context.

However, as shown by the left two columns of Figure 2, the 11-month-olds looked longer while listening to the NPs sliced from the functor than to the NPs from the nonce functor during the first block, $t(15) = 2.246$, $p = .04$. No looking time difference was observed for the two test trial types during the second block, $t(15) = -0.49$, $p = .631$.

The significant effect in the first block suggests faster and easier NP parsing using the functor in 11-month-old infants. Note that the functor co-occurred with phrase-final prosodic cues in Experiment 1. In Experiment 2, we further tested if 11-month-olds could use the function word cue for phrasal parsing when the NP ended with no phrase-final prosody, but rather, with conflicting phrase-internal prosodic cues.

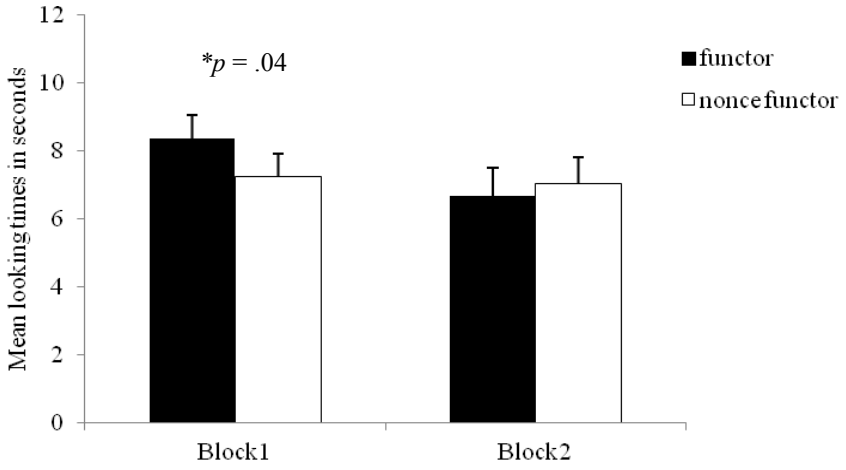

Figure 2. Eleven-month-olds' looking (listening) times to the two types of test trials, functor context versus nonce functor context.

3. Experiment 2

3.1. Participants, Stimuli, Design and Prediction

Participants were another group of 11-month-old monolingual Quebec-French-learning infants. In Experiment 2 we used the same NP+VP sentences as in Experiment 1, but the stimuli were re-recorded and recreated. The same female native speaker of Quebec French as Experiment 1 recorded the sentences in Table 3. Cross-spliced recordings were used to create the final sentences and to ensure that the subject-NPs contained no phrase-final prosody (see Table 3). The original NPs that included the adjective *imposant* had a post-nominal modifier (*varié* or *copié*), and had a phrase-internal prosody after the adjective *imposant*. For the cross-splicing, we took the part of

the subject-NP (Det+N+Adj) before the words *varié* and *copié*, and conjoin this part with the VPs that started with *va* or *ko* (from the /k/ burst). For the NP portion, the cutting point in the original sentences was at the end of the word *imposant* plus the following pause, just before the beginning of the post-nominal modifier (*varié* or *copié* (before the burst of /k/)). Note that *varié* and *copié* were included to induce phrase-internal prosody for the preceding Det+N+Adj, which could serve as an NP. As in Experiment 1, the adjective *imposant* was the last word of the spliced NPs in the sentences used in the familiarization, although it was intended to be phrase-internal in Experiment 2. Note also that the first syllable of the modifiers *varié* and *copié* were identical to the first word of the VPs (*va* and *ko* respectively). This ensured that the co-articulation of *imposant* and the following word in the final cross-spliced sentences would be natural.

Test stimuli were the spliced subject-NPs that were used to form the familiarization stimuli. The visual stimuli for the pre-trial and the attention-getter were the same as those in Experiment 1. The same bird animation was used. Its mouth was manipulated to move synchronously with the speech stimuli of Experiment 2.

Familiarization trials presented the *va* and *ko* sentences. The trials had a length of 7.87 seconds on average. Each sentence was on average 3.2 seconds, and there was an inter-sentence interval of 721 milliseconds. The test trials presented the two exemplars of one NP five times and lasted 11.26 seconds in total, with an average inter-stimulus silence of 1 second.

Table 3. Sentences for sound recording before and after cross-splicing.

Rec. 1	**[Le niveau imposant ~~varié~~]** sauvait l'entente des cours. "The varied imposing level saved the agreement of classes."
Rec. 2	[Ce patron insolent] **va gâcher l'enquête des jeunes.** "The insolent boss will waste the survey of the young ones."
Cross-spliced	**[Le niveau imposant ~~varié~~] va gâcher l'enquête des jeunes.**
Rec. 3	**[Un produit imposant ~~copié~~]** sauvait l'entente des cours. "The copied imposing product saved the agreement of classes."
Rec. 4	[Ce patron insolent] **ko cibler l'usage du client.** "The insolent boss ko target the use of the client."
Cross-spliced	**[Un produit imposant ~~copié~~] ko cibler l'usage du client.**
Rec. 5	**[Le niveau imposant ~~copié~~]** sauvait l'entente des cours. "The copied imposing level saved the agreement of classes."
Rec. 6	[Ce patron insolent] **ko cibler l'usage du client.** "The insolent boss ko target the use of the client."
Cross-spliced	**[Le niveau imposant ~~copié~~] ko cibler l'usage du client.**
Rec. 7	**[Un produit imposant ~~varié~~]** sauvait l'entente des cours. "The varied imposing product saved the agreement of classes."
Rec. 8	[Ce patron insolent] **va gâcher l'enquête des jeunes.** "The insolent boss will waste the survey of the young ones."
Cross-spliced	**[Un produit imposant ~~varié~~] va gâcher l'enquête des jeunes.**

The procedure and design (Table 4) were identical to those of Experiment 1, except that the prosodic cues after *imposant* were phrase-internal instead of phrase-final. We predicted that if infants used functors to parse the first three words (Det+N+Adj) as a possible NP despite the lack of phrase-final prosody, they should discriminate the two types of test trials. We expected that without NP-final prosodic cues, infants may be slow in using functors for parsing.

Table 4. Stimuli and design for Experiment 2.

Group 1 **Familiarization**	**Group 2** **Familiarization**
[Le niveau imposant ***~~varié~~*** *]* ***va*** *gâcher l'enquête des jeunes.*	*[Le niveau imposant* ***~~copié~~*** *]* ***ko*** *cibler l'usage du client.*
[Un produit imposant- ***~~copié~~*** *]* ***ko*** *cibler l'usage du client.*	*[Un produit imposant* ***~~varié~~*** *]* ***va*** *gâcher l'enquête des jeunes.*
Test trials: *Le niveau imposant* ***~~varié~~*** (functor context) versus *Un produit imposant* ***~~copié~~*** **(**nonce functor context**)**	**Test trials:** *Le niveau imposant* ***~~copié~~*** (nonce functor context) versus *Un produit imposant* ***~~varié~~*** **(**functor context**)**

3.2. Results

Looking times for the two test trial types ("functor" and "nonce functor") were analyzed in paired t-tests. The two trial types did not differ when all trials were analyzed together, $t(15) = 0.652$, $p = .524$. Paired t-tests were also performed for the two blocks separately, as in Experiment 1. As shown by the left two columns of Figure 3, no looking time difference were observed during the first block, $t(15) = -0.566$, $p = .58$. The right two columns show that during the second block, infants looked longer while listening to the NPs from the functor than to the NPs from the nonce functor, $t(15) = 1.888$, $p = .078$. The marginal difference in the later block shows that infants were slow in using functors for phrasal parsing when prosodic cues were conflicting. These results showed nonetheless an emerging ability in 11-month-olds to use the functor *va* for parsing subject-NP, even when phrase-final prosody was absent.

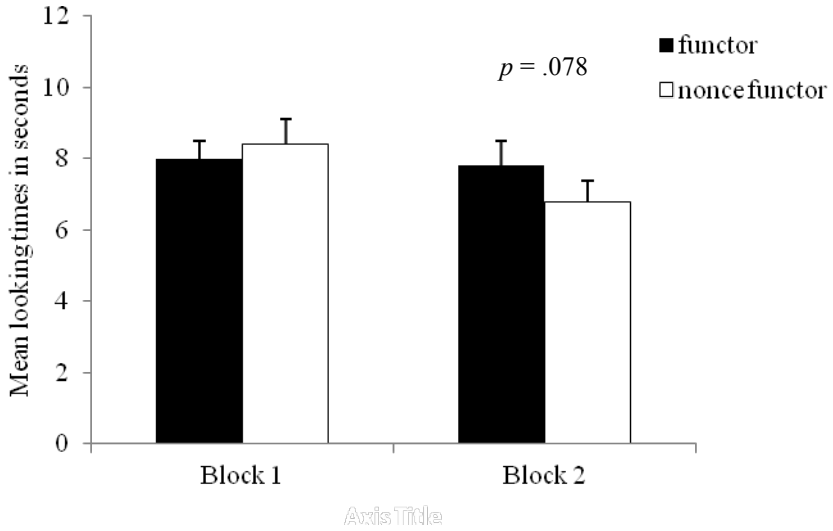

Figure 3. Infants' looking (listening) times to the two types of test trials, NPs from functor context versus NPs from nonce functor context.

5. Discussion

Our experiments showed that by 11 months of age infants use functors for phrasal parsing. Our results suggest that infants are sensitive to the co-occurrence of phrase-final prosodic cues and functors at phrasal edges. When the two kinds of cues were co-present (Experiment 1), 11-month-olds used the functor to assist phrasal parsing. In Experiment 2, the two kinds of cues were conflicting with the functor indicating a phrasal boundary, but the prosody indicating a phrase-internal sequence. Infants in Experiment 2 perceived this discrepancy and showed less efficient use of the functor alone for phrasal parsing. The more efficient use of the functor for phrasal parsing in Experiment 1 than in Experiment 2 suggests that infants perceived both kinds of phrase-boundary cues when they were present, and that they used both for phrasal parsing. Furthermore, infants in Experiment 2 revealed an emerging ability to use the functor alone for phrasal parsing in the later half of the test trials despite of the conflicting prosodic information. We expect that with more robust knowledge of functional items at a later stage of acquisition, infants should eventually learn to better use functors alone for phrasal parsing when phrase-final prosody is absent in speech. This ability would be helpful for learning and processing syntactic structures since phrasal level prosody may not always be present in running speech.

The functor *va* did not facilitate phrasal parsing in 8-month-olds even when phrase-final prosodic cues co-occurred (Experiment 1), whereas in 11-month-olds the effect of this functor for phrasal parsing was observed in both the good prosody condition (Experiment 1) and the adverse prosody condition (Experiment 2). These results suggest that the use of functors for phrasal parsing develops between 8 and 11 months of age. We

note that the results of the 8-month-olds do not mean that infants at this age cannot use prosody to parse phrases. Since the functor and nonsense-functor trials in Experiment 1 both contained phrase-final prosody, a lack of discrimination of the NPs from the two types of context could be due to equally successful prosody-based parsing in both contexts. Experiment 1 was not designed to be a direct test of the role of prosody alone for parsing. Nevertheless, we believe that 8-month-olds can use prosodic cues to parse phrases, considering the findings of previous studies (e.g., Nazzi, et al., 2000; Seidl & Cristià, 2008). In fact, the use of prosodic cues to phrasal and clausal units has been observed across ages in the field. For example, prosodic cues to parsing are used to resolve syntactic ambiguity by toddlers (e.g., Dautriche, Cristia, Brusini, Yuan, Fisher, & Christophe, 2014) and by adults (e.g., Millotte, René, Wales, & Christophe, 2008). In the present study the combined results of our 11-month-olds in the two experiments offer support for the effect of prosody for phrasal parsing.

Taken together, our experiments yielded a few interesting findings. The results suggest that infants before one year of age can use function words for phrasal parsing, even when prosodic cues to phrases were absent in speech. When both kinds of cues were present, phrasal parsing was more efficient: infants took advantage of the co-occurring functor and prosodic cues at the phrasal edge. These results support the proposal that infants use functional items and prosodic cues for bootstrapping grammatical acquisition (e.g., Christophe, Milotte, Bernal, & Lidz, 2008; Morgan, Shi, & Allopenna, 1996; Shi, 2014). Our findings are coherent with the previous literature on infants' processing of functional items (e.g., Hallé, Durant, & de Boysson-Bardies, 2008; Höhle & Weissenborn, 2003; Shi & Lepage, 2008; Höhle, et al., 2004; Marquis & Shi, 2012; Mintz, 2006; Shi, et

al., 2006; Shi & Lepage, 2008; Shi & Melançon, 2010; Shi, Werker, & Cutler, 2006) and prosody (e.g., Nazzi, et al., 2000; Seidl, 2007; Seidl & Cristià, 2008; Soderstrom, Seidl, Kemler Nelson & Jusczyk, 2003). The ability to parse continuous speech into syntactically relevant units at such a young age prepares infants for subsequent acquisition of more sophisticated linguistic structures.

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