24-Month-Olds' Sensitivity to the Syntactic Role of Function Words in English Sentences: Noun Phrase Determiners

Yarden Kedar, Marianella Casasola and Barbara Lust
Department of Human Development
Cornell University

Does the lexicon alone determine reference or does syntactic phrase structure contribute to this process as well? Researchers have proposed contrasting responses to this question. Some take young children's frequent omissions of functional categories as evidence for diminished syntactic knowledge, arguing instead that children rely primarily on lexical categories in the early stages of language acquisition (e.g., Radford 1990, 1997, Tomasello 2000a, 2000b, 2002, Tsimpli, 1991). In contrast, others argue for early access to functional categories, even when these are absent in children's speech (Boser, Lust, Santelmann, & Whitman 1992, Demuth 1994, Gerken & McIntosh 1993, Hyams 1992, Lust 1994, Poeppel & Wexler 1993, Weissenborn 1990). These debates are important to learning theories, which point to exposure and statistical frequency, and to current linguistic theory, which defines functional categories as the heads of their own projections (Abney 1987, Chomsky 1995), hence granting them a central role in the language faculty.

Functional categories include grammatical elements such as determiners, complementizers and inflections, which are realized in language by function words (e.g., *the*, *and)* and morphemes *(*e.g., *-ed, -s*). This category stands in contrast to lexical categories (nouns, verbs, adverbs and adjectives), which are realized in language by content words, that is, words that convey meaning (e.g., *ball*, *beauty*). Although function words are highly frequent in language, and have been proposed to be important cues for detecting morphological, phrasal and sentential structure (Clark & Clark 1977, Gerken, Landau, & Remez 1990, Gerken & McIntosh 1993, Maratsos 1982, Shi, Morgan & Allopenna 1998), young children have been consistently reported to omit function words from their speech at early stages of productive language (Bloom 1970, Bowerman 1973, Braine 1976, Brown 1973, Brown & Bellugi, 1964).

Accordingly, several researchers assume that young 'telegraphic speakers' are not aware of function words as distinct units with a syntactic and semantic role. Instead, children in the early stages of language development are argued to rely on lexical categories represented by content words such as nouns and verbs for inferring meaning and reference in other speakers' speech (Bowerman 1973, Brown 1973, Macnamara 1982, Pinker 1982, 1984, Schlesinger 1971, 1981, Tomasello 2000a, 2000b, 2002).

This view, however, has been challenged by evidence that young children are sensitive to function words in perception, despite omitting them from their productive speech (Gelman & Taylor 1984, Gerken et al. 1990, Katz, Baker, & Macnamara 1974, Petretic & Tweney 1977, Shady 1996, Shady, Jusczyk, & Gerken 1998, Shipley, Smith, & Gleitman 1969). These findings support the claim that young children and even newborns (Shi, Werker, & Morgan 1999) are, in fact, able to distinguish between function words versus content or nonsense words, based on a constellation of perceptual and distributional cues. Based on this evidence, it seems that children's omission of function words is not the outcome of a deficit in linguistic competence, but rather, as Gerken and colleagues have suggested, the result of motor constraints on the alteration between weakly and strongly stressed syllables in speech production at early stages of language acquisition (Gerken et al. 1990, Gerken & McIntosh 1993, Gerken 1996, Boyle & Gerken 1997).

One remaining question is whether young children can not only detect function words in the speech stream, but also whether they can distinguish between function words which carry

different syntactic roles. Gerken and McIntosh (1993) tested young children's awareness of the syntactic role of specific function words, and how such knowledge might assist them in determining meaning and reference in Determiner Phrases (DP) and Noun Phrases (NP). Toddlers of 23- to 28 months were tested in a picture-identification task requiring them to point to a picture when hearing one of four imperative sentence types in which a concrete noun (e.g., *bird*, *car*) was preceded by: (i) a determiner that was grammatical in that context (e.g., *show me the bird*); (ii) an auxiliary that was not grammatical in that context (e.g., *find me was bird*); (iii) a nonsense-syllable, serving as an unfamiliar function word (e.g., *point gub bird for me*); or (iv) no function word (e.g., *show me _ bird*).

Toddlers performed better when the grammatical determiner ('*The*') rather than the ungrammatical auxiliary ('*Was*') or a nonsense-syllable ('*Gub*') preceded the target word. However, the researchers found no difference in pointing between the grammatical and the omitted-function-word conditions, in contrast to previous findings (Shipley et al. 1969, Petretic & Tweney 1977). Based on these differences in toddlers' motor response to the grammatical and ungrammatical sentences, Gerken and McIntosh (1993) argued that function words must play a significant role in children's comprehension of language. Their results provide evidence of early access to grammatical structure and the role of the Determiner Phrase (DP) in determining reference. Thus, young children are not only aware of the distributional properties of specific function words (e.g., '*The*' occurring only in Noun Phrases), but they may use this knowledge in determining reference for lexical items.

Similar to Gerken and McIntosh (1993), the current study explored 24-month-olds' sensitivity to function words and investigated the importance of functional categories for children who are still in early periods of acquiring their first language. We hypothesized that 24-month-olds would demonstrate awareness of the grammatical role of function words, specifically, identifying a determiner ('*The*') as the functional head of a phrase with a Noun Phrase (NP) complement (i.e., DP, or determiner phrase) and associating this Determiner head with reference of the constituent (see Abney, 1987, for example).

Different from Gerken and McIntosh's (1993) study, the current study used the preferential looking paradigm (Golinkoff, Hirsh-Pasek, Cauley & Gordon 1987, Hirsh-Pasek & Golinkoff, 1996), a procedure that uses toddlers' looking behavior as an indicator of their comprehension of linguistic input. Based on Gerken and McIntosh's (1993) study's design, a general template of a sentence varying a single function word in a pre-nominal position was used to encourage toddlers to look towards one of two images presented (a target image and a distractor). Differently from that study however, an interrogative sentence rather than an imperative sentence was used (i.e., *Can you see [Function-Word] [Noun]*?). Consequently, toddlers had to listen to the whole sentence including the target noun (i.e., a noun referring to one of the two images presented) before they could realize whether it was grammatical or not. Four types of this template were used: A grammatically-correct English sentence using the determiner '*The*' (e.g., "*Can you see the ball?*") and three types of ungrammatical English sentences in which '*The*' was replaced with another English function word that is ungrammatical in the specific context (the conjunction *And*); a nonsense function-word (*El*); or an omitted-function-word condition (henceforth, *None*).

Goals and Predictions. One goal of this study was to determine whether Gerken and McIntosh's (1993) results would replicate with a preferential-looking procedure with 24-month-old toddlers. A second goal was to extend previous findings by testing 24-month-olds' discrimination of an omitted-function-word condition from a grammatical condition. Lastly, extending the comparison in Gerken and McIntosh's study between a determiner (*The*) and an auxiliary (*Was*), we wanted to find out whether toddlers would discriminate a determiner from a conjunction (*And*).

We predicted (i) more correct first looks; (ii) shorter latencies; and longer looking time (iii) towards the target image after hearing a grammatical, rather than an ungrammatical sentence. Such findings would support the hypothesis that 24-month-olds already identify the grammatical position and role that are appropriate for the determiner '*The*'.

Method

Participants. Sixteen 24-month-old toddlers (9 females, 7 males) from monolingual English-speaking families participated. Written parental reports indicated that toddlers were full term (at least 37 weeks of gestational age), had no history of auditory or visual impairment, and were not exposed only to English on a regular basis. Toddlers ranged in age from 23;11 to 24;30 (months; days) and had a mean age of 24;01 (*SD* = 13.55 days). Participants were recruited through a letter given to parents at the time of their child's birth. Once toddlers were within the appropriate age range for the study, parents were contacted again and invited to participate. All toddlers were given a small toy in appreciation.

Visual stimuli. The visual stimuli were 16 color images of everyday objects (ball, bed, book, brush, car, cup, hat, phone, plane, shoe, spoon, truck) and animals (bird, cat, dog, duck). These images, which are depicted in Appendix A, were selected because their linguistic labels were likely to be familiar to most 16-months-old English-learning toddlers according to the norms of the MacArthur-Bates Communicative Development Inventory. The selected images were placed in eight pairs according to their familiarity proportion, so that each pair of images had approximately the same familiarity proportion (e.g., ball: 93%, book: 90%).

Auditory stimuli. A native-English female speaker produced all auditory stimuli in infant-directed speech. Three auditory items were recorded for use in the control trials: "*Look! Look at these!*"; "*Look! Look at that!*"; and "*Wow!*". Auditory stimuli used in test trials were sentences containing one of the four sentence types (i.e., grammatical, ungrammatical, nonsense, or an omission of the function word) and a noun, prepared in two stages: First, 64 sentences with all possible combinations of function word (*N* = 4) and noun (*N* = 16) were recorded (e.g., "*Can you see <u>the ball</u>?*; ... *<u>el ball</u>?*; ... *<u>and car</u>?"*). Next, to guarantee an equivalent level of vividness, clarity, and inflection in all test sentences, the best exemplar of the sequence "*can you see"* was chosen and used as a prototype in all 64 edited sentences that were eventually used in the test trials. Similarly, for each of the function words (*the*, *and*, *el*), a single exemplar was chosen for all 16 sentences in which it appeared. Finally, the best exemplar of each noun was used in all 16 sentences in which it appeared. Thus, 64 edited sentences were used in the final set of stimuli. To prevent a confounding factor of sentence length, all edited sentences lasted exactly 2 s. Eight sentence lists were created, composed of eight sentences each, with different combinations of function word and noun. As can be seen in Appendix B, each list had two sentences of each kind.

Apparatus. Adjacent experimental and control rooms were used. In the experimental room, three monitors (one center, two on either side) were used to present the visual stimuli. A camcorder, focused on the toddler's face, was linked to a monitor in the control room, which was used by the experimenter to observe the toddler and parent. All test sessions were video recorded, allowing offline coding of toddlers' looking behavior. The *Habit 2000* program (Cohen, Atkinson & Chaput, 2000) was used for presenting the images and controlling their order and timing of presentation. *Supercoder X* (Hollich, 2003), a program which allows a frame-by-frame analysis of the recorded looking behavior was used to calculate each dependent measure.

Procedure. Parents were asked to sign a consent form, approved by a university committee on human subjects. Parents also completed a vocabulary questionnaire of their toddlers' estimated comprehension and production ability for the 16 nouns used in the study. In the experimental room, toddlers were seated on their parent's lap facing the monitors. Each of the eight sentence lists was presented to two toddlers. Order of appearance of the four sentence

types was pseudo-randomized across lists. Each child saw 16 trials overall (eight control trials and eight test trials). In a control trial, toddlers were viewing a pair of images while hearing the recorded voice encourage their looking to the images. This control trial was then followed by a test trial that presented the same image pairs after hearing a test sentence. Thus, each test session consisted of eight control-test trial cycles (each lasting approximately 24 s). An attention-getter (a flashing, chiming, green circle) directed children's attention to the center monitor prior to the beginning of each control-test trial cycle.

Control trials. Toddlers heard phrases preparing them for the coming images (either "*Look! Look at these"!* or "*Look! Look at that"!*). Two images then appeared simultaneously on the side monitors, followed by the word "*Wow*".

Test Trials. Preceding the presentation of the same objects seen during the prior control trial, toddlers heard a test sentence. Once the test sentence ended, the same two images (seen in the preceding control trial) appeared for 6 s. Each image was presented on the same side as it had been in the control trial. The test sentence was heard again 2 s into the image pair presentation.

Each image in a pair served as the target image for half of the participants and as the distractor for the other participants. Toddlers saw each image pair only once, thus avoiding a familiarity effect. To control for side preference, the side in which the target image appeared was pseudo-randomized within each test session in the following order: left; right; left; left; right; left; right; right. Test sessions lasted approximately 3 min.

Coding. Test sessions were coded off-line using *SuperCoder X* (Hollich, 2003). First, an observer coded all 16 test sessions. Next, a second observer coded five randomly chosen toddlers. The average correlation between the two observers was 0.999 and ranged from 0.997 to 0.999, indicating high inter-observer reliability. Both coders were blind to the sentence list they were coding. Only toddlers who attended to at least six out of the eight test sentences were included in the final sample. Four missing test cells (out of 128 total) from four different toddlers were left out of the analyses due to fussiness or non-attentiveness (n = 3) or a technical problem that prevented seeing where the toddler was looking (n = 1).

Three dependent variables were calculated from the coded data: (i) *First Look*: To see whether toddlers looked correctly towards the target image on their first look or not; (ii) *Latency*: Time passed from the moment the two images appeared until toddlers looked towards the target image; (iii) *Proportion of Looking Time* (henceforth, PLT) to the target image during test trials.

Results

No main effect for Sex, Sex x Function-Word Type interaction effect, or any significant differences among the three ungrammatical sentence types were found in the following analyses.

First Look to Target Image. Test trials were categorized as either YES or NO based on toddlers' first look towards the target image (*YES*: N = 78; *NO*: N = 46). More first looks to target occurred on average after toddlers heard the grammatical sentence type than after hearing any of the other three ungrammatical sentence types[1]. A generalized estimating equation logistic regression analysis for effects of Function-Word Type on correct first look yielded a significant main effect, χ^2 (3) = 10.95; p = .012. Specifically, an analysis of the differences of least square means showed a significant difference in correct first look between '*The*' and '*And*', χ^2 (1) = 14.33; p < .001, and between *The* vs. *El*, χ^2 (1) = 10.58; p < .01. However, as was the case in Gerken and McIntosh's (1993) pointing task, the difference between '*The*' and '*None*' was not statistically significant.

[1] The proportion of correct (i.e., looking towards the target image) first look differed depending on the function-word type which was used in the preceding test sentence: '*The*': 84% of first looks were correct; '*And*': 48%; '*El*': 55%; '*None*': 65%.

Latency. To normalize the data and meet the model assumptions, a square root transformation was carried out. A general linear model ANOVA yielded a significant main effect for Function-Word Type, F (3,15) = 4.157; p = .011. Planned comparisons showed significant differences in latency between the grammatical and each of the ungrammatical Function-Word Types: '*The*' versus '*And,* t (15) = -3.728, p =.002; '*The*' versus '*El*', t (15) = -3.319, p =.005; '*The*' versus '*None*', t (15) = -3.103, p = .007. This result is depicted in Figure 1.

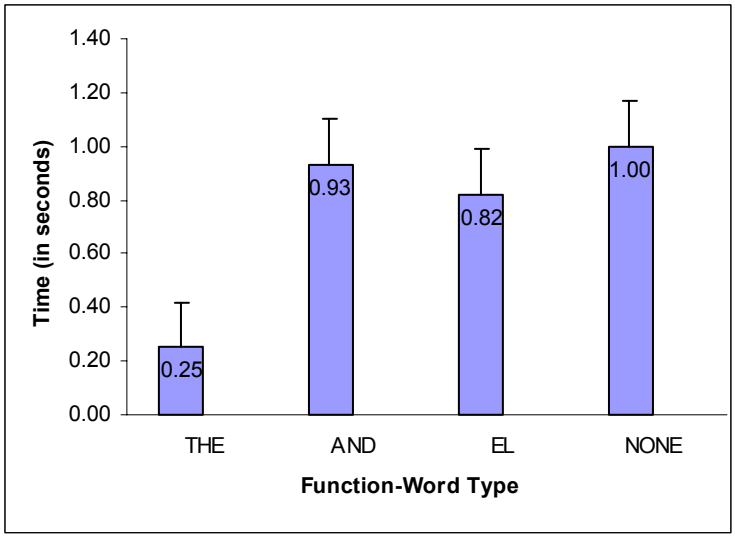

Figure 1 – Duration in seconds (i.e., latency*)* taken for toddlers to look at target image

Proportion of Looking Time to Target. Toddler's PLT towards the target image during test trials were calculated and the overall averages of PLT to the target image were computed for each Function-Word Type, as shown in Figure 1:

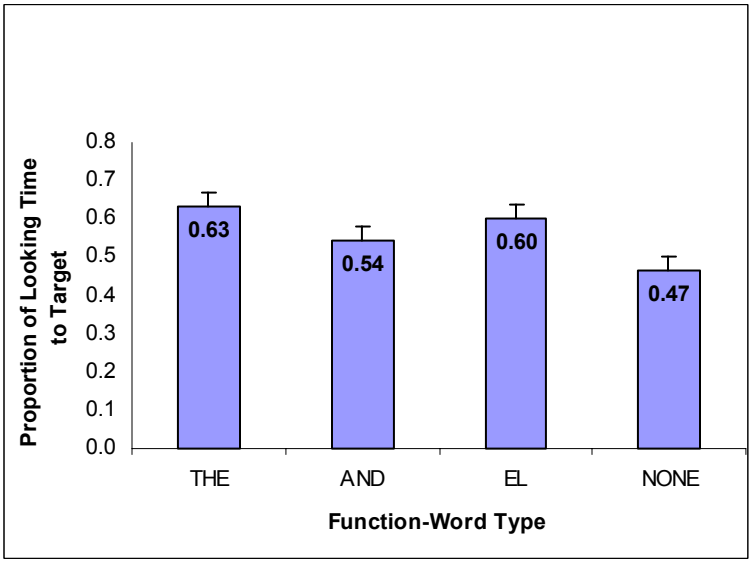

Figure 2 – Toddlers' average proportion looking time to the target image during test trials

During test trials, toddlers looked on average the longest towards the target image after hearing the grammatical sentence type. A general linear model analysis of variance (ANOVA) did not yield a significant main effect for Function-Word Type, F (3,15) = 1.436; *ns*.

We next review our findings in detail:

First Look to Target. During test trials, toddlers looked differently on their first look to the target image depending on the function-word type presented. Specific differences in correct first look were found between '*The*' versus '*And*', and between '*The*' versus '*El*', though the difference between '*The*' versus '*None*' was not significant. Interestingly, these results replicate Gerken & McIntosh's (1993) findings despite the use of a different methodology. This similarity in results may arise because the *First Look* measure is quite similar to the pointing measure used in Gerken and McIntosh's study: Both measures examine the child's first reaction to the stimuli presented, though in different modalities (i.e., motor/pointing versus perceptual/looking). The question that rises is whether the insignificant difference between the grammatical versus the omitted-function-word conditions reflects the child's linguistic competence at two years of age, or if this insignificant result is due only to some insensitivity embedded in the measure itself. The results in the latency measure seem to support the latter option.

Latency. In support of our hypothesis, toddlers looked at the target image significantly faster after hearing a grammatical rather than an ungrammatical sentence - including in the comparison between the grammatical and the omitted-function-word conditions. Thus, although all toddlers eventually located the target image during test trials, it is clear that hearing the determiner '*The*' in a grammatical context facilitated orientation and reference to the image which related to the noun toddlers had previously heard, whereas orientation to the target image after hearing the ungrammatical sentence types was much longer.

Proportion of Looking Time. Although toddlers looked, on average, the longest towards the target image after hearing a grammatical test sentence, results from this analysis did not reach statistical significance. We argue that this probably relates to a mismatch between the PLT measure and the particular task we used, but not to the toddlers' linguistic competence. This claim is based on previous questions raised regarding the effectiveness and validity of the PLT measure in similar tasks (Schafer & Plunkett, 1998), and on our realization that because this measure relies on toddlers' looking behavior throughout the entire 6-second-long test trial, it allows a great deal of randomness in looking, thus probably weakening the immediate and direct effect of the test sentence. For example, a toddler hearing one of the ungrammatical sentence types might have been initially distracted (as predicted), but still had sufficient time to look at the target image and hence 'compensate' for the ungrammaticality effect.

Discussion

Our results replicate previous findings reported by Gerken and McIntosh (1993) and suggest that at 24 months of age toddlers are already sensitive to the grammatical role of a determiner ('*The*') in comparison to a conjunction ('*And*'). Additionally, this study extends Gerken and McIntosh's findings by demonstrating 24-month-olds' discrimination of an omitted-function-word condition from a grammatical condition.

Importantly, the findings described above were obtained despite the fact that the target noun was presented in all sentences and its representative image always seen, thus making the task of reference relatively easy, regardless of the grammaticality of the sentence. This sensitivity to the functional head may be even more substantial for young children in cases in which there is no clear referential context, for example, identifying an unknown word as a noun as a result of hearing '*the*' preceding it. Moreover, in all test trials, even when function words were omitted or changed, the basic syntactic structure of the sentence was not changed (i.e., the subject-verb-object (SVO) word order).

These findings illustrate how crucial syntactic structure—in this case, functional elements –can be in the online computation of speech for young learners of language. Our results show in support of previous findings (Gerken & McIntosh, 1993) that 24-month-olds are aware of the distributional syntactic properties of the determiner '*The*' and may consult this in detecting

determiner phrases and noun phrases, hence contributing to referent identification and semantic interpretation.

In sum, these new findings provide converging evidence to Gerken and McIntosh's study with a new methodology. They extend previous results in that they also show children's discrimination of functional category omission from grammatical functional categories, and discrimination of a determiner ('*The*') which heads DP from a conjunction ('*And*') This adds further support to the hypothesis that functional categories provide an early syntactic framework for language acquisition in general, and to the syntax-semantics interface in particular.

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APPENDIX A: VISUAL STIMULI

CUP 	PHONE 
BED 	HAT 
PLANE 	TRUCK 
CAR 	SHOE 
BALL 	BOOK 
BIRD 	DOG 
BRUSH 	SPOON 
DUCK 	CAT 

APPENDIX B: SENTENCE LISTS

Trial	**Target**	**Side of Target**	**List A1** *Can you see…*	**List A2** *Can you see…*	**List A3** *Can you see…*	**List A4** *Can you see…*
1.	PHONE	Left	**the** phone?	**and** phone?	_ phone?	**el** phone?
2.	BED	Right	**el** bed?	**the** bed?	**and** bed?	_ bed?
3.	PLANE	Left	**el** plane?	**the** plane?	_ plane?	**and** plane?
4.	CAR	Left	**and** car?	**el** car?	**the** car?	_ car?
5.	BALL	Right	_ ball?	**and** ball?	**the** ball?	**el** ball?
6.	BIRD	Left	_bird?	**el** bird?	**and** bird?	**the** bird?
7.	BRUSH	Right	**the** brush?	_ brush?	**el** brush?	**and** brush?
8.	DUCK	Right	**and** duck?	_duck?	**el** duck?	**the** duck?

Trial	**Target**	**Side of Target**	**List B1** *Can you see…*	**List B2** *Can you see…*	**List B3** *Can you see…*	**List B4** *Can you see…*
1.	CUP	Left	**the** cup?	**and** cup?	_ cup?	**el** cup?
2.	HAT	Right	**el** hat?	**the** hat?	**and** hat?	_ hat?
3.	TRUCK	Left	**el** truck?	**the** truck?	_ truck?	**and** truck?
4.	SHOE	Left	**and** shoe?	**el** shoe?	**the** shoe?	_ shoe?
5.	BOOK	Right	_ book?	**and** book?	**the** book?	**el** book?
6.	DOG	Left	_ dog?	**el** dog?	**and** dog?	**the** dog?
7.	SPOON	Right	**the** spoon?	_ spoon?	**el** spoon?	**and** spoon?
8.	CAT	Right	**and** cat?	_ cat?	**el** cat?	**the** cat?