Thematic role assignment in the L1 acquisition of Tagalog: Use of word order and morphosyntactic markers

Journal:	*Language Acquisition: A Journal of Developmental Linguistics*
Manuscript ID	HLAC-2017-11-A-0053.R1
Manuscript Type:	Article
Keywords:	Verbal Morphology, Nominal Morphology, Processing, Child-Directed Speech

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It is a common finding across languages that young children have problems in understanding patient-initial sentences. We used Tagalog, a verb-initial language with a reliable voice-marking system and highly frequent patient voice constructions, to test the predictions of several accounts that have been proposed to explain this difficulty: the frequency account, the Competition Model, and the incremental processing account. Study 1 presents an analysis of Tagalog child-directed speech which showed that the dominant argument order is agent-before-patient, and that morphosyntactic markers are highly valid cues to thematic role assignment. In Study 2, we used a combined self-paced listening and picture verification task to test how Tagalog-speaking adults and 5- and 7-year-old children process reversible transitive sentences. Results showed that adults performed well in all conditions, while children's accuracy and listening times for the first noun phrase indicated more difficulty in interpreting patient-initial sentences in the agent voice compared to the patient voice. The patient voice advantage is partly explained by both the frequency account and incremental processing account.

Keywords: verbal morphology; nominal morphology; processing; child-directed speech; Philippine-type languages

1. INTRODUCTION

One of the critical tasks in language acquisition is identifying who did what to whom in a sentence. A number of studies across different languages have shown that children initially follow a word order strategy and interpret the first noun as the agent, resulting to reversals of the agent and patient roles in patient-initial sentences. This has been observed not just in languages which heavily rely on word order for expressing thematic roles, like English (Bever 1970; de Villiers & de Villiers 1973; Gertner, Fisher &

Eisengart 2006; Tager-Flusberg 1981; Van der Lely 1994) and Portuguese (Coelho de Barros Pereira Rubin 2009), but also in languages with a more flexible word order wherein thematic roles are assigned by morphosyntactic markers, such as German (Dittmar, Abbot-Smith, Lieven & Tomasello 2008; Lindner 2003), Hebrew (Frankel, Amir, Frenkel & Arbel 1980), Hungarian (MacWhinney, Pleh & Bates 1985), Italian (Bates, MacWhinney, Caselli, Devescovi, Natale & Venza 1984), Japanese (Hakuta 1977), and Serbo-Croatian and Turkish (Slobin & Bever 1982).

However, the reasons behind children's difficulties with interpreting semantically reversible non-canonical sentences (patient-before-agent; referred to from here on simply as non-canonical sentences) are still a matter of debate. In this research, we used Tagalog to test three of the proposed claims: the frequency account, the Competition Model and the incremental processing account. We first review the evidence supporting each claim, and then discuss properties of Tagalog which are interesting for testing the predictions that these models make. This review is followed by an analysis of word order and morphosyntactic markers in Tagalog child-directed speech (Study 1). Finally, we describe an experiment which tests Tagalog-speaking children's use of word order and morphosyntactic markers for interpreting simple transitive sentences (Study 2).

1.1. Possible reasons behind children's difficulties with non-canonical sentences

Different accounts have been proposed to explain children's difficulties with non-canonical sentences. These claims shed light on the strategies which children use for sentence comprehension, and when children are expected to acquire non-canonical word order in different languages.

1.1.1. The frequency account

According to the frequency account, children have difficulties with non-canonical sentences such as passives because these are infrequent in the input, hence children do not yet have enough experience to interpret such sentences correctly (Demuth 1989; Gordon & Chafetz 1990; Kline & Demuth 2010). Corpus studies have shown that child-directed speech contains only few passive sentences in languages where passives are acquired rather late (e.g., Abbot-Smith & Behrens 2006 for German; Gordon & Chafetz 1990 for English). For example, Gordon & Chafetz (1990) found that in English child-directed speech, passives comprised only 0.04% of the total input.

Other studies have shown that when English-speaking children are exposed to more non-canonical sentences by experimentally increasing the input, children showed earlier acquisition of such constructions. Brooks & Tomasello (1999) showed that after extensive exposure to passive sentences, 3;5 English-speaking children could use novel verbs in passive constructions. Also, 4;0 English-speaking children who were exposed to increased passive input in story sessions produced more passive sentences and showed better comprehension (Vasilyeva, Huttenlocher & Waterfall 2006).

An earlier acquisition of passives has also been found in languages where passives are frequent. Children already produced passives at 2;0 in Jakarta Indonesian (Gil 2006), at 2;1 in Inuktitut (Allen & Crago 1996), Kiswahili and Kigiriama (Alcock, Rimba & Newton 2011) and K'iche' Mayan (Pye & Poz 1988), at 2;5 in Zulu (Suzman 1987) and at 2;8 in Sesotho (Demuth 1989; Kline & Demuth 2010). At the age of 3 years, Sesotho-speaking children showed comprehension and generalization of the passive structure to novel verbs (Demuth, Moloi & Machobane 2010).

1.1.2. The Competition Model

The *Competition Model* (MacWhinney 1987; MacWhinney & Bates 1989) also recognizes the significance of frequency on the acquisition of non-canonical sentences, but it additionally emphasizes the notion of reliability of linguistic cues, e.g., word order and case-marking, for thematic role assignment. This framework provides a way to quantify the availability and usability of a particular cue. According to this model, there are three different properties that determine the relevance of a cue for sentence interpretation: availability, reliability, and validity. Cue availability refers to how frequent a cue is present in the speech input, while cue reliability reflects how often a cue points to the correct thematic role assignment. The overall measure of a cue's validity is the product of its availability and reliability.

The model predicts that sentences in which all cues point to the same argument as the agent are easier for children to understand compared to structures in which these cues are in competition with each other indicating different agents. This claim is supported by experimental findings in different languages (Abbot-Smith & Serratrice 2015 for Italian; Dittmar et al. 2008 for German; Janssen, Meir, Baker & Armon-Lotem 2015 for Russian; Staron & Kail 2004 for Polish). For example, Dittmar et al. (2008) showed that 2-year-old German-speaking children could correctly interpret only those sentences wherein both word order and case-markers indicated the same agent.

When two cues indicate different agents, the model predicts that the cue with higher validity will win the competition and will be used for assigning thematic roles. Additionally, the most valid cue is predicted to be acquired earliest, resulting in cross-linguistic differences concerning the age at which children start to use a cue for sentence interpretation. For instance, word order has higher validity in English compared to Dutch, and English-speaking children use word order for comprehension

earlier than their Dutch counterparts (McDonald 1986). In addition, the same study showed that in Dutch, word order has a higher cue validity than case-marking (present in pronouns), and that Dutch learning children rely on word order for thematic role assignment instead of relying on case-marking which is what adults do. In contrast, an early reliance on case-marking instead of word order has been found in Russian (Janssen et al. 2015) and Turkish (Slobin & Bever 1982), which fits to the high validity of case-marking in these languages.

1.1.3. The incremental processing account

Like the Competition Model, the incremental processing account claims that a listener uses several cues like word order and morphosyntactic markers for thematic role assignment, however, the account incorporates the importance of when a cue is given in a sentence. According to this account, children process incoming information incrementally and immediately similar to adults, but a problem occurs when a late-arriving cue is in conflict with the interpretation of previously given information, because children have difficulties in revising an earlier interpretation (Trueswell & Gleitman 2004; 2007).

Children's difficulty in revising an initial interpretation has been found in studies involving ambiguities in prepositional phrase attachment (Trueswell, Sekerina, Hill & Logrip 1999), long-distance dependencies (Omaki, Davidson White, Goro, Lidz & Phillips 2014), and quantified noun phrases (Musolino & Lidz 2006). For example, Trueswell et al. (1999) showed that when listening to sentences such as *Put the frog on the napkin in the box* while being presented with an array of objects outside of an empty box such as a frog, a napkin, and a frog on a napkin, adults and children first looked at the frog on the napkin (destination interpretation). After hearing the second prepositional phrase *in the box*, adults correctly moved the frog which was on the

napkin into the box. However, children did not revise their destination interpretation, and still moved the frog to the napkin.

As regards passive sentences, Huang, Zheng, Meng & Snedeker (2013) showed that in Mandarin, 5-year-olds correctly interpreted passives more often when the passive marker BEI (indicates that the first noun phrase is a patient) appeared after a pronoun ("It BEI seal eat" It is eaten by the seal), compared to when the marker appeared after a referential noun ("Seal BEI it eat" The seal is eaten by it). The authors argued that children do not immediately assign a thematic role to a non-referential noun (e.g., *it*), but do so for a referential noun. Therefore, there is no need to revise an earlier thematic role assignment for the former when the passive marker is encountered, but a revision is needed for the latter. This finding supports Trueswell, Kaufman, Hafri & Lidz's (2012) claim that processing is easier when morphosyntactic markers are used for guiding instead of revising an initial interpretation.

1.2. Thematic role assignment in Tagalog

Tagalog is a language that has structural properties that allow for further testing the accounts targeting children's difficulties with non-canonical sentences. Tagalog is different from previously studied languages, because due to its canonical verb-initial order and voice-marking system, the thematic role of an argument is always unambiguously marked in basic sentences.

In this language, the verb is inflected for voice, aspect, and mood. The voice marker on the verb assigns the *ang*-phrase its thematic role (Himmelmann 2005)[1]. Most

[1] Voice-marking and mood are conflated in Tagalog verbs. In this work, the voice-markings used also signal realis mood. See Himmelmann (2005) for a longer discussion on voice-marking and mood in Tagalog.

important for the purpose of our study, the marker *ang* precedes the noun. The agent voice (AV) infix –*um*–denotes that the *ang*-phrase is the agent as in (1, 3). The patient voice (PV)[2] infix –*in*– indicates that the *ang*-phrase is the patient as in (2, 4). Therefore, a mere change in the voice-marking on the verb in a given sentence reverses the roles of agent and patient. Based on a corpus of written text, Cooreman, Fox & Givón (1984) claimed that the patient voice is more frequent than the agent voice given transitive verbs. This finding makes Tagalog interesting because the *ang*-phrase is usually the patient instead of the agent which is comparable to passives in other languages.

(1) H<**um**>ihila ng baboy **ang** baka[3]
AV[4]-pull pig cow
'The cow is pulling a pig.'

(2) H<**in**>ihila ng baboy **ang** baka
PV-pull pig cow
'The/A pig is pulling the cow.'

(3) H<**um**>ihila **ang** baka ng baboy

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[2] It must be noted that the agent voice and patient voice differ from active and passive voice, as there is no argument demotion in a symmetrical voice language (Riesberg & Primus 2015). Therefore, in the patient voice, the agent is not demoted into an oblique, unlike in a passive.

[3] *Ang* is pronounced as /ʔaŋ/ and *ng* as /naŋ/.

[4] *AV* refers to agent voice, *PV* to patient voice, and *LIN* to linker.

AV-pull cow pig

'The cow is pulling a pig.'

(4) H<**in**>ihila **ang** baka ng baboy

PV-pull cow pig

'The/A pig is pulling the cow.'

The order of the post-verbal arguments in Tagalog is relatively free (Schachter 2015), and its basic order remains controversial with various proposals from different researchers: verb-agent-patient (VAP) for both voices (Buenaventura-Naylor 1975; Manueli 2010; Schachter 2015); verb-patient-agent (VPA) for the agent voice and VAP for the patient voice (Billings 2005); VAP for the agent voice and VPA for the patient voice (Aldridge 2002); and VAP for the patient voice and both VAP and VPA for the agent voice (Guilfoyle, Hung & Travis 1992; Kroeger 1993b). What is important for the current study is that word order is irrelevant for assigning thematic roles in basic sentences, so (1) and (3) have the same meaning, because they are both in the agent voice, and only the order of the nouns differs between the two sentences. The same goes with examples (2) and (4).

Only a few studies have focused on the acquisition of Tagalog. There is evidence that children follow a word order strategy for thematic role assignment. Using a sentence-picture matching task, Segalowitz & Galang (1978) found that 3-, 5-, and 7-year-old Tagalog-speaking children correctly interpreted VAP sentences in the patient voice but misinterpreted VPA sentences in the agent voice. Follow-up testing using verb-medial sentences (agent-verb-patient [AVP] in the agent voice and patient-verb-agent [PVA] sentences in the patient voice), which are grammatical but mostly occur in

formal, written language, was also performed. The children correctly interpreted AVP sentences in the agent voice but also PVA sentences in the patient voice, showing that the children did not always just assign the agent role to the first noun.

There is also evidence from a more recent study on Tagalog relative clauses showing that children have an agent-initial preference in comprehension (Tanaka, O'Grady, Dean, Kim, Hattori, Soriano & Bondoc 2015). In agent relative clauses ([5] verb is inflected for the agent voice), the agent is mentioned first; while patient relative clauses ([6] verb is inflected for the patient voice) have a patient-initial order. Five-year-olds correctly interpreted more agent relative clauses than patient relative clauses.

(5) Lalaki-ng h<**um**>ahabol ng babae
Man-LIN <AV>chase woman
'The man that is chasing the/a woman.'

(6) Lalaki-ng h<**in**>ahabol ng babae
Man-LIN <PV>chase woman
'The man that the/a woman is chasing.'

Taken together, these studies provide evidence that Tagalog-speaking children use an agent-first strategy for thematic role assignment. However, it is yet to be investigated how children interpret VAP sentences in the agent voice and VPA sentences in the patient voice. In Segalowitz & Galang's (1978) study, voice, word order, and the ambiguity of the thematic role of the first noun phrase were confounded. In verb-initial sentences wherein the thematic role of the first noun phrase was unambiguous, the agent voice condition was always patient-before-agent and the patient

voice was always agent-before-patient. In contrast, in verb-medial sentences, wherein the thematic role of the first noun phrase was ambiguous, the agent voice was always agent-initial and the patient voice was always patient-initial. In Tanaka et al.'s (2015) study, agent voice constructions were always agent-initial, and patient voice constructions were always patient-initial.

1.3. The current research

In the current research, we take advantage of Tagalog's voice-marking system and flexible word order to test the predictions of the frequency account, the Competition Model, and the incremental processing account. In order to make precise predictions, we first looked at child-directed speech. We then used a combination of online and offline tasks to analyze children's comprehension of basic transitive sentences. To our knowledge, the current study is the first in Tagalog acquisition research to use an online task. An online task can show whether or not children process the voice marking on the verb and the marker on the noun in real time, allowing comprehension to be tested before the end of a sentence, and thus is most appropriate to test the predictions of the incremental processing account.

We analyzed children's use of word order and the morphosyntactic markers for thematic role assignment, to answer the following questions: (1) Do Tagalog-speaking children use word order or the morphosyntactic markers—voice marker on the verb and noun marker—for thematic role assignment? (2) How does this use differ among age groups?

Tagalog is interesting because the patient voice is more frequent than the agent voice. If the high occurrence of patient voice sentences in written Tagalog is also found in child-directed speech, the frequency account predicts that children would show better comprehension for patient voice sentences than for agent voice sentences.

Tagalog's complex but reliable mapping of verbal voice-marking and noun morphology is also informative for testing the claims of the Competition Model. Processing of sentences wherein word order and morphosyntactic markers indicate the same agent is expected to be easier compared to sentences wherein these two cues contradict each other. The more valid cue (word order or morphosyntactic markers) is also predicted to be acquired earlier and used for thematic role assignment when the cues are in conflict.

Lastly, the incremental processing account predicts that children immediately assign a thematic role based on the information that is so far present in the unfolding input. According to this account, difficulties with non-canonical sentences are due to their problem in revising an initial thematic role assignment. The fact that the thematic role assignment in Tagalog verb initial sentences is never ambiguous allows us to check this claim. Because Tagalog is canonically verb-initial and the noun markers occur before the noun, the morphosyntactic markers that are needed for thematic role assignment are already given before the first noun is encountered. Therefore, children are expected to immediately assign the correct thematic roles when they encounter the morphosyntactic markers in the sentence. According to this account, children should not have problems in interpreting patient-initial sentences in Tagalog and should show no differences in their ability to comprehend the two voices.

In Study 1, we investigated the validities of word order and the morphosyntactic markers using a corpus of Tagalog child-directed speech, and calculated the frequency of agent voice and patient voice utterances in order to formulate precise predictions for Study 2. In Study 2, we used a combined self-paced listening and picture verification task to investigate 5-year-old and 7-year-old children's use of word order and/or voice-

marking on the verb and the noun marker to identify the agent in simple transitive sentences.

2. STUDY 1: CORPUS STUDY ON TAGALOG CHILD-DIRECTED SPEECH

As the different accounts emphasize the importance of the input that children hear, we first looked at a corpus of child-directed speech from Tagalog-speaking adults. We investigated adults' use of word order and the morphosyntactic markers in transitive sentences, and calculated the corresponding cue availability, cue reliability, and cue validity. We also looked at the distribution of agent and patient voice utterances, to see whether patient voice is more frequent than agent voice in transitive sentences in child-directed speech, just as found in a written corpus (Cooreman, Fox & Givón 1984).

2.1. Method

The data were taken from transcriptions of 6 video recordings of 3 Tagalog-speaking children's daily family interactions (2 half-hour videos per child), which were collected by Marzan (2013). The videos were recorded when the children were between 2;4 and 2;7. The transcriptions were in the *Codes for the Human Analysis of Transcripts (CHAT)* format, which is part of the *Child Language Data Exchange System or CHILDES* (MacWhinney 2000).

A total of 3,739 child-directed utterances of different adults were analyzed. These included declaratives, imperatives, and questions, which all varied from single-word utterances to complex sentences. First, the utterances with verbs were manually identified by a native Tagalog speaker, excluding verbs which occurred in idiomatic expressions or frozen phrases. Next, those verbs which were determined to be causative transitives based on Hopper & Thompson's (1980) criteria (e.g., volitionality and

affectedness) were selected, e.g., *hinila* 'pulled' was counted but not *narinig* 'heard.' The presence of voice-marking on the verbs, as well as the markers on the nouns, were then coded.

Following Dittmar et al. (2008), cue availability was computed by dividing the number of times a cue occurred in the corpus by the total number of transitive causative utterances. Cue reliability was counted as the number of times a cue correctly indicated the agent of the action, divided by the total number of utterances wherein the cue was available. Cue validity was then calculated by multiplying cue availability and cue reliability. The word order cue was considered available when a verb occurred with two noun phrases. The morphosyntactic cue was considered available when an utterance contained a voice-inflected verb and at least one marked noun. We also calculated how many of the transitive verbs were uninflected or inflected for the agent voice or the patient voice. The data were submitted to Bayesian binomial tests (Kruschke, 2011) to estimate the relative proportion of agent voice and patient voice, and agent-initial and patient-initial utterances. The estimate of the inferred average is reported as $\tilde{\mu}$, and the 95% uncertainty intervals are enclosed in [ ] in this paper.

2.2. Results and discussion

There was a total of 1,140 child-directed utterances which contained a verb. Among these utterances, 594 were highly causative transitives, and these utterances were the ones used in the subsequent analyses. The availability, reliability, and validity of word order and the morphosyntactic cue are illustrated in Figure 1. The word order cue was available in 34% of the utterances, as these contained both an agent and a patient. In 87% of these utterances containing the word order cue, the agent occurred as the first noun phrase, indicating the reliability of the word order cue. These calculations resulted in a cue validity of 29%.

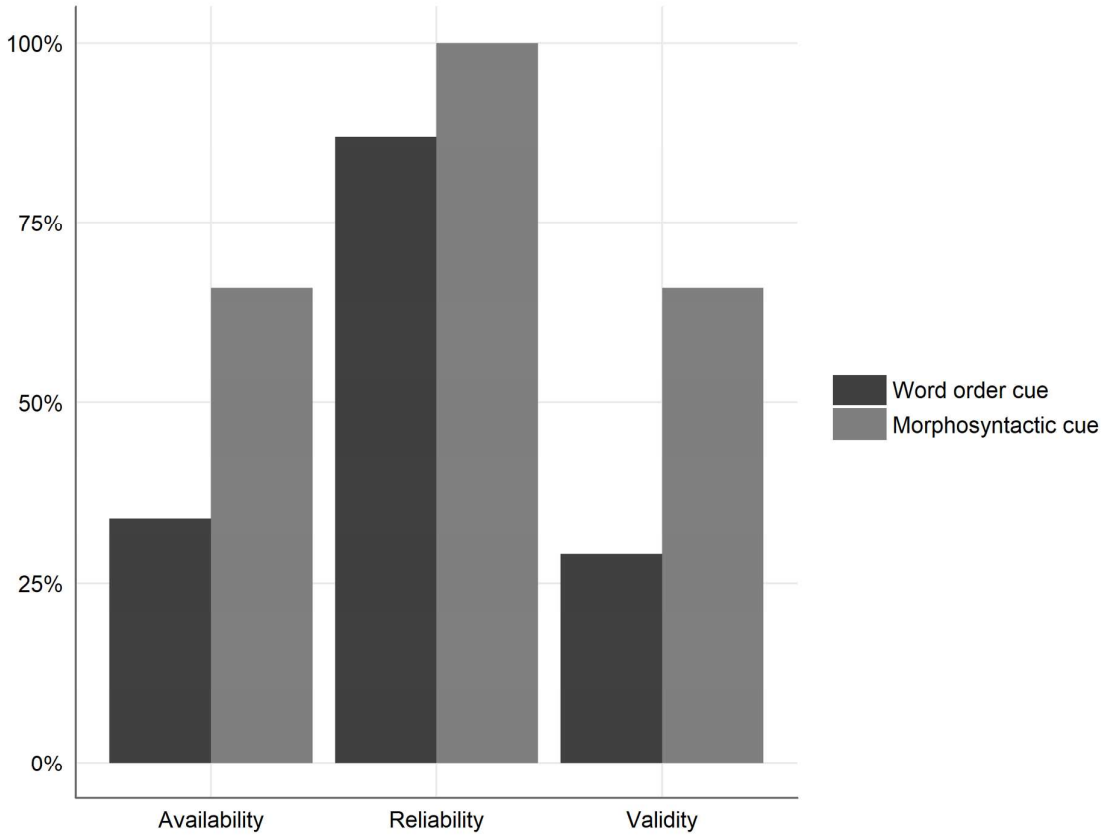

Figure 1. Word order cue and morphosyntactic cue's availability, reliability, and validity in transitive causative sentences in Tagalog child-directed speech from Study 1.

The morphosyntactic cue was available in 66% of the utterances. The cue was not available in 23% of the utterances because voice was not marked on the verb (20% were root words, 3% were inflected only for aspect). The rest of the utterances contained only a verb and not a single noun (11%). The morphosyntactic cue was reliable in 100% of the times that it was available, resulting to a cue validity of 66%.

In order to make precise predictions for the frequency account, we checked the frequency of agent and patient voice in utterances with causative transitive verbs and at least one noun phrase (515 utterances). Among these utterances, 21% were inflected for the agent voice, while 53% were inflected for the patient voice. The remaining 26% contained verbs which were not inflected for voice. Among the agent voice utterances,

95% were agent-initial or contained only an agent; while 85% of the patient voice utterances were agent-initial or contained only an agent. The Bayesian binomial test showed that there was a higher posterior probability of patient voice-marked verbs in both agent-initial ($\tilde{\mu}$ = .69, [.64, .74]) and patient-initial sentences ($\tilde{\mu}$ = .86, [.76, .95]). Moreover, we also found a higher posterior of an agent-initial word order in both the agent voice ($\tilde{\mu}$ = .94, [.89, .98]) and the patient voice ($\tilde{\mu}$ = .84, [.80, .88]). These results corroborate the finding from the written corpus (Cooreman et al. 1984)—patient voice is more frequent than the agent voice in transitive sentences.

The results of Study 1 provide more precise predictions based on the accounts: first, according to the Competition Model, sentences in which word order and morphosyntactic cues assign the agent role to the same noun (agent-initial) should be easier to process than sentences wherein these cues indicate different agents (patient-initial). Second, given the higher validity of the morphosyntactic cue, the model also predicts that children would rely more on the morphosyntactic markers than on word order when these two cues are in conflict. On the other hand, given the higher frequency of patient voice compared to agent voice, the frequency account predicts that children would be more likely to use the morphosyntactic markers in the patient voice than in the agent voice. As agent-initial sentences are also more frequent compared to patient-initial sentences regardless of voice, the account predicts easier processing of sentences in the agent-initial condition compared to the patient-initial condition.

3. STUDY 2: EXPERIMENT ON TAGALOG SPEAKING-CHILDREN'S USE OF WORD ORDER AND MORPHOSYNTACTIC MARKERS FOR THEMATIC ROLE ASSIGNMENT

In Study 2, we used a combined self-paced listening and picture verification task to determine if children rely on word order and/or morphosyntactic markers on the verbs

and the nouns for thematic role assignment. In this paradigm, which was based on Marinis & Saddy (2013), participants first saw a picture and then heard an agent voice- or patient voice-inflected verb. They were instructed to press a button on a game controller to listen to the next fragment of the sentence. At the end of the sentence, they had to indicate whether the sentence matched the picture that was displayed. We crossed voice (agent voice, patient voice), order of mention of the animal doing the action in the picture (from here on referred to as word order: agent-initial, patient-initial), and matching of the interpretation of the markers on the verb and the noun with the scene depicted on the picture (match, mismatch).

Based on the results of Study 1 and in line with the frequency account, children are predicted to show higher accuracies and overall shorter listening times in the patient voice condition compared to the agent voice. Also, the higher frequency of agent-initial sentences predicts shorter listening times for the first noun phrase in agent-initial compared to patient-initial sentences.

The Competition Model predicts that sentences in which word order and morphosyntactic markers assign the agent role to the same noun phrase—agent-initial sentences—would be easier to understand than sentences in which the cues assign the agent role to different noun phrases—patient-initial sentences. The Competition Model also predicts that when these cues conflict, children should use the most valid cue. Given the result from Study 1, they should rely on the morphosyntactic markers rather than on word order, so accuracy for the patient-initial conditions across voice conditions should be above chance.

Lastly, according to the incremental processing account, patient-initial sentences should not be more difficult than agent-initial sentences, nor agent voice constructions than patient voice constructions, because with Tagalog's verb-initial structure, there is

no need to revise an earlier thematic role assignment. Moreover, the incremental processing account predicts that children are able to use the morphosyntactic markers online, so longer listening times for mismatching morphosyntactic markers compared to matching morphosyntactic markers should be observed by the first noun phrase.

3.1. Method

3.1.1. Participants

A total of 185 typically-developing children were recruited from Metro Manila, Philippines. Data gathered from 128 children (64 per age group: 5-year-olds, and 7-year-olds) were used for the analysis. Fifty-seven children had to be excluded because they did not show understanding of the picture verification task during the practice trials (38 5-year-olds), had more than 4 errors out of the 16 filler items (5 5-year-olds and 6 7-year-olds), always responded with a *match* for the experimental items (3 5-year-olds and 4 7-year-olds), or answered before the sentence was finished (1 5-year-old). In total, 47 5-year-olds and 10 7-year-olds were excluded based on these criteria.

All the children were from Tagalog-speaking households. The 5-year-old children (mean age: 5;7, age range: 5;1-5;11, males: 28) were Kindergarten 1 students from three elementary schools, while the 7-year-olds (mean age: 7;5, age range: 7;0 – 7;11, males: 23) were Grade 2 students from the same schools.

Sixty-four adults from Metro Manila were recruited as a control group (mean age: 19, range: 18-22, males: 24). No participant reported a history of language delay, and psychiatric or neurologic disorder. Informed consent was obtained from the adult participants and from the parents of the children. There was no monetary compensation for participation.

3.1.2. Materials

The materials were created such that three factors—voice (agent voice, patient voice), word order (agent-initial, patient-initial), and matching of the sentence and the picture (match, mismatch) could be varied. For the match condition, the interpretation of the markings on the verb and nouns corresponded to the scene as depicted on the picture, while for the mismatch, the picture showed a role-reversal. This manipulation resulted in four conditions per voice: agent-initial match, patient-initial match, agent-initial mismatch, and patient-initial mismatch (see Table 1 for sample experimental sentences in the agent voice conditions and Table 2 for the patient voice conditions).

Table 1. Sample experimental items for the agent voice-inflected verb *hila* 'pull,' given a picture of a cow pulling a pig in Study 2, see Figure 2a.

a	H<**um**>ihila/	**ang**	baka/	tuwing umaga/	ng	baboy/	sa maputik/	na bukid/	Agent-initial Match
	<AV>pull		cow	every morning		pig	in muddy	LIN field	
b	H<**um**>ihila/	ng	baboy/	tuwing umaga/	**ang**	baka/	sa maputik/	na bukid/	Patient-initial Match
	<AV>pull		pig	every morning		cow	in muddy	LIN field	
	'The cow is pulling a pig every morning in the muddy field.'								
c	H<**um**>ihila/	ng	baka/	tuwing umaga/	**ang**	baboy/	sa maputik/	na bukid/	Agent-initial Mismatch
	<AV>pull		cow	every morning		pig	in muddy	LIN field	

d	H<**um**>ihila/	**ang**	baboy/	tuwing umaga/	ng	baka/	sa maputik/	na bukid/	Patient-initial Mismatch
	<AV>pull		pig	every morning		cow	in muddy	LIN field	

'The pig is pulling a cow every morning in the muddy field.'

Note. A slash indicates the end of a fragment.

Table 2. Sample experimental items for the patient voice-inflected verb *hila* 'pull,' given a picture of a pig pulling a cow in Study 2; see Figure 2b.

a	H<**in**>ihila/	ng	baboy/	tuwing umaga/	**ang**	baka/	sa maputik/	na bukid/	Agent-initial Match
	<PV>pull		pig	every morning		cow	in muddy	LIN field	
b	H<**in**>ihila/	**ang**	baka/	tuwing umaga/	ng	baboy/	sa maputik/	na bukid/	Patient-initial Match
	<PV>pull		cow	every morning		pig	in muddy	LIN field	

'The pig is pulling a cow every morning in the muddy field.'

c	H<**in**>ihila/	**ang**	baboy/	tuwing umaga/	ng	baka/	sa maputik/	na bukid/	Agent-initial Mismatch
	<PV>pull		pig	every morning		cow	in muddy	LIN field	
d	H<**in**>ihila/	ng	baka/	tuwing umaga/	**ang**	baboy/	sa maputik/	na bukid/	Patient-initial Mismatch
	<PV>pull		cow	every		pig	in muddy	LIN field	

morning

'The cow is pulling a pig every morning in the muddy field.'

Note. Slash indicates the end of a fragment.

Semantically reversible sentences were created from sixteen verbs which depict transitive actions: *hila* 'pull,' *silip* 'peek at,' *sipa* 'kick,' *huli* 'capture,' *palo* 'hit,' *pasan* 'give a piggyback ride,' *kagat* 'bite,' *tira* 'hit,' *sagip* 'rescue,' *gamot* 'cure,' *pili* 'choose,' *tawag* 'call,' *salo* 'catch,' *karga* 'carry,' *baril*, 'shoot,' and *habol* 'chase' (see Appendix A for a complete list of experimental sentences). In reversible sentences, either noun can serve as the agent or the patient of the action described by the verb.

Each of the lexical verbs was assigned to an animal pair from a pool of eight animals. We used animals as agents and patients to keep animacy constant. Each sentence was divided into fragments: verb, first noun phrase, temporal adverb, second noun phrase, and spatial adverb. Temporal and spatial adverbs were also included in the sentences, to serve as spill-over and wrap-up regions.

For each lexical verb, two corresponding pictures with reversed roles were created. See Figure 2a, b for examples. Mirror images of these were also used, to counterbalance the side on which each animal or each agent appears.

a.  b. 

Figure 2a, b. Pictures for the lexical verb *hila* 'pull' in Study 2. Mirror images of these two were also used in the experiment.

Additionally, 16 other transitive verbs (e.g., *kain* 'eat', *inom* 'drink', and *basa* 'read') were chosen to create non-reversible sentences serving as fillers. These verbs were inflected for the agent and patient voice. The same animals as in the experimental items were used as agents, while common concepts such as *mango*, *house*, and *book* were used as themes. Matching and mismatching (incorrect agent or theme) filler images were created.

The pictures were digital, colored, and had a resolution of 1650 x 1276 pixels. The sentences were audio recorded by a Tagalog native speaker using a normal speaking rate but with short pauses between the fragments, for easy splicing. The recording was done in an audio recording booth using the Audacity 2.1.0 program (Audacity Team 2015), which was also used for splicing the fragments. The fragments contained no silence.

Each combination of picture and audio-recorded sentence was distributed into sixteen different lists, following a Latin square design. Voice was a between-subjects variable: Half of the participants were given the agent voice lists, and the other half were tested on the patient voice lists. In each list, each experimental condition appeared four times, and all lexical verbs and pictures appeared only once. In total, there were 32 trials per list—16 experimental trials and 16 fillers. The picture and the sentence matched for half of the trials in each list, but not for the other half. The stimuli were presented through DMDX version 5 (Forster & Forster 2014), in a pseudo-randomized order, such that the same condition was not presented for more than three consecutive trials. The same program also recorded the time when the participants pressed the

button to call for the next fragment of the sentence, which was in turn, used to measure listening times.

3.1.3. Procedure

The participants were tested individually in quiet class rooms—in schools for the children, and in the university for the adults. The experimenter sat next to each participant, and presented the experiment on a 13-inch laptop which was approximately 50 centimeters away from the participant.

First, the experimenter checked whether the children knew the animals and actions in the stimuli, by asking them to point to the concept which was named. Four concepts were presented at a time. This task was also given to the adults. If a mistake was made during this pre-experiment phase, the participant was reminded to look once more at the pictures, and to listen carefully. The experimenter proceeded to the practice session of the main experiment only if the participant had successfully identified all of the items.

The participants were informed that a picture would be presented on the screen, and a sentence would be played in short segments through the headphones, and that they had to press a button on a game controller to hear the next segment. After each sentence, their task was to say whether or not the sentence matched the picture. Every trial started with the presentation of a picture, which remained on the screen until the sentence was finished. The presentation of the first sentence fragment started automatically 2500ms after the picture had appeared on the screen. The experiment was programmed such that the fragments stopped playing if the button was pressed too early, in order to prevent the participants from continuously just pressing the button. In addition, the participants were also reminded that no item could be replayed, so they should listen carefully. At the end of each sentence, a bell sound was played, and the

stimulus picture was replaced by a screen with a check and a cross. The children were instructed that after they heard the bell, they should verbally respond whether or not the sentence they heard matched the picture they saw; while the adults used two other buttons on the game controller to give their *match* and *mismatch* responses.

Before the actual experiment, the participants were given four practice items, which were non-reversible transitive sentences like the fillers. For the first item, the experimenter provided hand-over-hand assistance to the children. During the whole practice phase, feedback was given. During the actual experiment, no feedback was given except for reminders when they were not waiting for the word to be finished before pressing the button for the next fragment. In addition, to motivate the children to finish the task, the experiment was presented as a game, in which they had to help a boy reach a race's finish line. Before, halfway through, and after the experiment, a drawing of a boy in different stages of a race was presented on the screen.

3.1.4. Data analysis

A 2 x 2 x 2 x 3 factorial design was used. The independent variables were voice (agent voice, patient voice), word order (agent-initial, patient-initial), matching (match, mismatch) and age group (5-year-olds, 7-year-olds, adults). The dependent variables were accuracy of the picture verification response and listening times for the first noun phrase.

Statistical analyses were performed in R statistical software version 3.2.5 (R Core Team 2016). Bayesian hierarchical models were essential to account for the complexity of the fixed and random effects structure of the data (Gelman et al. 2014; McElreath 2016). The Bayesian models were fitted using the rstanarm package (Stan Development Team 2016), with predictors for voice, word order, matching, and age (5:7, children:adults); two-way interactions of voice and word order, voice and

matching, voice and age, word order and matching, word order and age, and matching and age; and three-way and four-way interactions of voice, word order, matching and age. Helmert contrasts were used for the age groups: comparing the 5-year-old group to the 7-year-old group, and both groups of children to the adult group. Voice, word order and matching were sum coded. All models were fitted with random intercepts for subjects and items. By-item slope adjustments were fitted for all predictors (Barr, Levy, Scheepers & Tily 2013). By-subject slope adjustments were included for voice, word order, matching, and their interaction but we omitted by-subject age group adjustments and their respective interactions as age group was a between-subjects factor.

The listening time for the first noun phrase was calculated by subtracting the fragment duration from the time between fragment onset and when the participant pressed the button to hear the next fragment. Listening times were log-transformed to account for right skew. The model predictors were the same as those in the fitted models for accuracy.

All models were fitted with weakly informative priors for each predictor. We calculated the 95% uncertainty intervals (enclosed in [ ] in this paper). Uncertainty intervals that do not contain zero show support for an effect of an independent variable on the dependent variable. We also calculated the proportion of posterior samples smaller than 0 (abbreviated as P(b<0)) which indicates a negative effect (i.e., lower accuracy or shorter listening times) given the data. Thus, the evidence supports a negative effect when P(b<0)) approaches 1, while a positive effect is supported when P(b<0) approaches 0. Values in between indicate inconclusive evidence for an effect. See Sorensen, Hohenstein & Vasishth (2016), and Nicenboim & Vasishth (2016) for an introduction to the use of Bayesian statistics in psycholinguistics.

3.2. Results

We present the accuracy results of the picture verification task, followed by the listening times for the first noun phrase in the self-paced listening task.

3.2.1. Accuracy

The mean accuracies and 95% confidence intervals per condition are shown in Figure 3. The Bayesian mixed effects model showed main effects of age, voice, and matching; and two-way interactions of age (children:adults) and matching, age (children:adults) and voice, word order and matching, and voice and matching (see Table 3). There were also three-way interactions age (children:adults), voice and word order; age (children:adults), word order and matching; and voice, word order and matching.

Interactions were inspected in nested contrasts calculated from the inferred samples of the Bayesian model. Nested comparisons inspecting the three-way interaction of voice, word order and matching showed that accuracy was higher in the patient voice compared to the agent voice in the agent-initial mismatch (coefficient = 1.97, [0.20, 3.75], P(b<0) < .02) and patient-initial match (coef = 5.77, [3.20, 9.04], P(b<0) < .001) conditions, but not in the agent-initial match (coef = -0.46, [-2.96, 2.13], P(b<0) = .64) or patient-initial mismatch (coef = -1.85, [-4.36, 0.51], P(b<0) = .94). However, further inspection showed that the patient voice advantage in the agent-initial mismatch condition was shown only by the children (coef = 3.31, [1.95, 4.69], P(b<0) < .001), and not by the adults (coef = 0, [-1.12, 1.18], P(b<0) = .51). Comparisons in the match condition also showed that children scored higher in agent-initial sentences compared to patient-initial sentences in the agent voice condition (coef = -5.84, [-7.54, -4.25], P(b<0) > .99), but not in the patient voice condition (coef = -1.09, [-2.64, 0.42], P(b<0) = .92); while the adults did not show an effect of order in either of the voice

conditions (agent voice: coef = -0.03, [-1.39, 1.19], P(b<0) = .52; patient voice: coef = 1.44, [-0.96, 4.58], P(b<0) = .14).

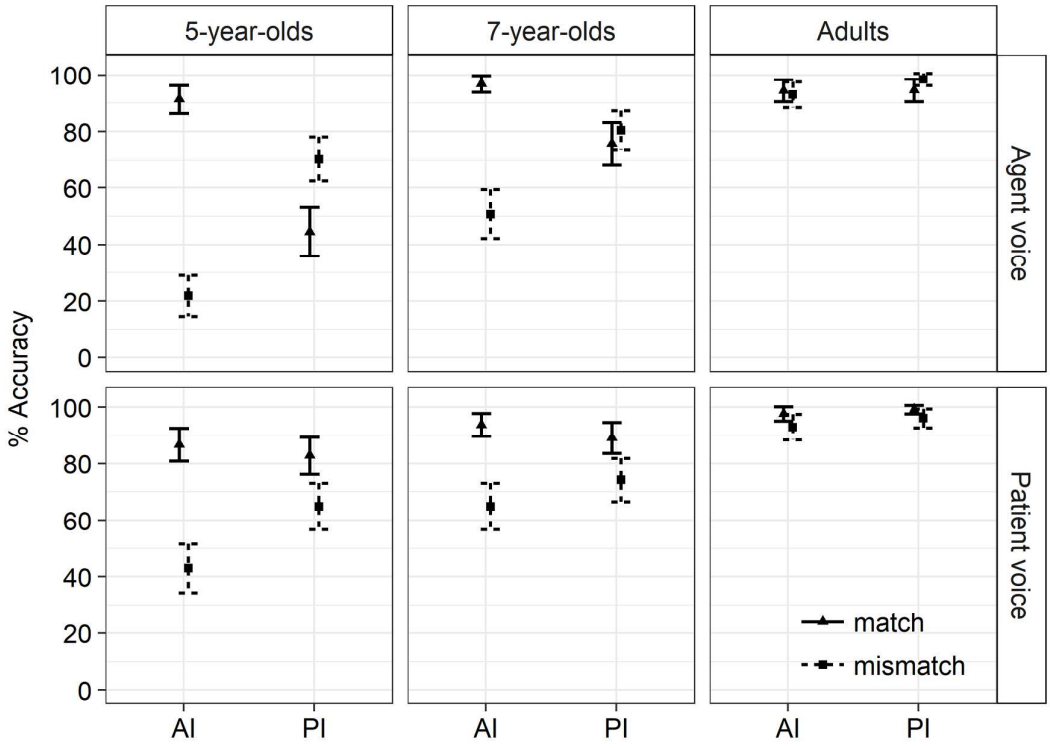

Figure 3. Mean accuracy with 95% confidence intervals for each condition per age group in Study 2.

Note. AI refers to agent-initial. PI refers to patient-initial.

Table 3. Summary of the fixed effects in the Bayesian model of the participants' accuracy in Study 2, including means, 95% uncertainty intervals, and P(b<0) which refers to the probability that the true parameter value is less than 0.

Comparison	Mean	Lower	Upper	P(b<0)
Intercept	2.20	1.95	2.46	<.001
Age(5:7)	8.61	5.76	11.67	<.001

Age(children:adults)	39.13	31.51	48.22	<.001
Voice	5.44	0.27	10.76	.02
Word order	-3.00	-7.99	1.78	.89
Matching	16.18	11.41	21.20	<.001
Age(5:7)*Voice	-1.99	-4.97	0.91	.90
Age(5:7)*Word order	1.46	-1.57	4.56	.16
Age(5:7)*Matching	0.55	-2.58	3.80	.36
Age(children:adults)*Voice	1.38	-6.19	9.91	.36
Age(children:adults)*Word order	-8.66	-17.07	-1.43	.99
Age(children:adults)*Matching	-10.02	-14.93	-5.47	>.99
Voice*Word order	-2.39	-7.10	2.07	.84
Voice*Matching	5.09	0.48	10.14	.02
Word order *Matching	14.07	9.11	18.83	<.001
Age(5:7)*Voice*Word order	0.51	-2.30	3.17	.35
Age(5:7)*Voice*Matching	-0.84	-3.98	2.46	.70
Age(5:7)*Word order*Matching	-1.60	-4.28	1.12	.87
Age(children:adults)*Voice*Word order	1.43	-6.64	9.03	.37
Age(children:adults)*Voice*Matching	8.29	0.92	16.96	.02
Age(children:adults)*Word order* Matching	-10.56	-18.86	-3.13	>.99
Voice*Word order*Matching	-10.02	-14.93	-5.47	>.99
Age(5:7)*Voice*Word order*Matching	0.97	-1.75	3.75	.22
Age(children:adults)*Voice*Word order*Matching	2.43	-5.93	9.81	.28

From the posterior samples of the accuracy model, we calculated 95% uncertainty intervals and the posterior probability that the accuracy was below chance (P(b<.5)) (see Table 4 for the agent voice and Table 5 for the patient voice). If responses are not different from chance, the uncertainty intervals are expected to contain the chance level threshold (0.5).

In the agent voice, the 5-year-olds showed below chance level responses in the agent-initial mismatch condition, chance level in the patient-initial match condition, and above chance responses in the other agent voice conditions. In the patient voice, the 5-year-olds showed chance level responses in the agent-initial mismatch condition, and above chance responses in others. The 7-year-old group performed at chance level in the agent voice agent-initial mismatch condition, and above chance in all other conditions. The adult controls showed above chance performance in all conditions.

Table 4. Summary of the posterior samples for each agent voice condition in the Bayesian model of the participants' accuracy in the picture verification task in Study 2, including means, 95% uncertainty intervals, and P(b<0.5) which refers to the probability that the true parameter value is less than 0.5.

Condition	Mean	Lower	Upper	P(b<.5)
5-year-olds				
Agent-initial Match	0.93	0.88	0.97	<.001
Agent-initial Mismatch	0.19	0.11	0.29	>.99
Patient-initial Match	0.43	0.30	0.57	.84†
Patient-initial Mismatch	0.73	0.61	0.83	<.001
7-year-olds				

Agent-initial Match	0.98	0.95	0.99	<.001
Agent-initial Mismatch	0.51	0.38	0.64	.44†
Patient-initial Match	0.79	0.69	0.88	<.001
Patient-initial Mismatch	0.83	0.75	0.91	<.001
Adults				
Agent-initial Match	0.96	0.92	0.99	<.001
Agent-initial Mismatch	0.95	0.90	0.98	<.001
Patient-initial Match	0.96	0.92	0.99	<.001
Patient-initial Mismatch	0.99	0.97	1	<.001

Note. The † denotes chance level performance.

Table 5. Summary of the posterior samples for each patient voice condition in the Bayesian model of the participants' accuracy in the picture verification task in Study 2, including means, 95% uncertainty intervals, and P(b<0.5) which refers to the probability that the true parameter value is less than 0.5.

Condition	Mean	Lower	Upper	P(*b*<.5)
5-year-olds				
Agent-initial Match	0.89	0.82	0.95	<.001
Agent-initial Mismatch	0.42	0.27	0.57	.86†
Patient-initial Match	0.85	0.77	0.92	<.001
Patient-initial	0.68	0.54	0.81	.006

Mismatch				
7-year-olds				
Agent-initial Match	0.95	0.90	0.98	<.001
Agent-initial Mismatch	0.69	0.55	0.82	.005
Patient-initial Match	0.91	0.85	0.96	<.001
Patient-initial Mismatch	0.79	0.67	0.89	<.001
Adults				
Agent-initial Match	0.98	0.96	1	<.001
Agent-initial Mismatch	0.95	0.90	0.98	<.001
Patient-initial Match	0.99	0.98	1	<.001
Patient-initial Mismatch	0.97	0.94	0.99	<.001

Note. The † denotes chance level performance.

3.2.2. Listening times

The mean listening times and 95% confidence intervals of each age group per sentence fragment in each experimental condition are presented in Appendix B. Statistical analyses reported below are only for the first noun phrase as this was the critical region in which the thematic role of the first mentioned argument and the match or mismatch to the scene displayed on the picture became evident. Listening times below -200 and above 4000ms were excluded (0.30%) because these were judged as extreme values based on histograms, following Marinis & Saddy (2013). Extremely short values

indicate premature responses and extremely long responses imply additional processing difficulty. The mean first noun phrase listening times and 95% confidence intervals per condition are shown in Figure 4.

The results showed main effects of age (children:adults), voice, and matching, and two-way interactions of order and matching, and age (children:adults) and matching on listening times for the first noun phrase region (see Table 6). The adults had shorter listening times compared to the children. All participants also had shorter listening times for the patient voice compared to the agent voice. Nested comparisons inspecting the interaction of word order and matching showed that there were longer listening times in mismatch than match in the agent-initial condition (coef = 0.85, [0.63, 1.06], P(b<0) < .001) but not in the patient-initial condition (coef = 0.10, [-0.11, 0.30], P(b<0) = .18). Overall, there were also longer listening times for patient-initial sentences than for agent-initial sentences in the match condition (coef = 0.41, [0.19, 0.63], P(b<0) < .001). Nested comparisons inspecting the three-way interaction of age, voice and matching showed that children had longer listening times in mismatch than in match in the patient voice (coef = 0.32, [0.14, 0.49], P(b<0) < .001) but not in the agent voice (coef = 0.13, [-0.04, 0.30], P(b<0) = .07); while adults had longer listening times for mismatch compared to match in both the agent voice (coef = 0.29, [0.17, 0.41], P(b<0) < .001) and the patient voice (coef = 0.20, [0.08, 0.33], P(b<0) < .001).

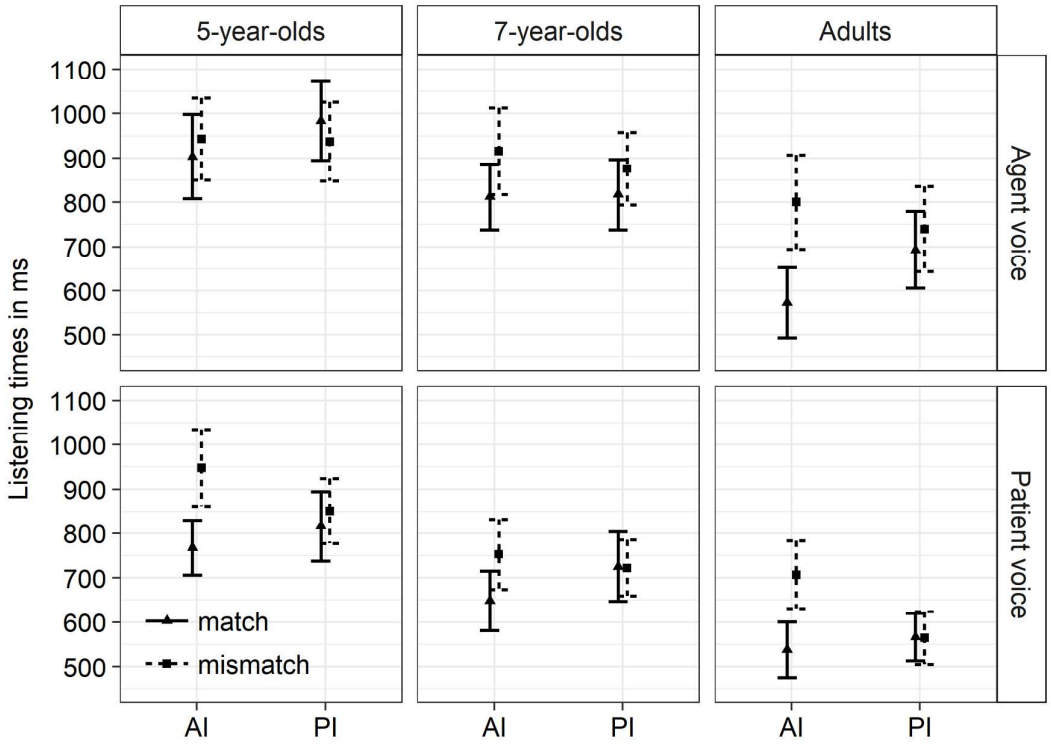

Figure 4. Mean listening times with 95% confidence intervals for the first noun phrase for each condition per age group in Study 2.

Note. AI refers to agent-initial. PI refers to patient-initial.

Table 6. Summary of the fixed effects in the Bayesian model of the participants' listening times for the first noun phrase region in Study 2, including means, 95% uncertainty intervals, and P(b<0) which refers to the probability that the true parameter value is less than 0.

Comparison	Mean	Lower	Upper	P(b<0)
Intercept	6.78	6.72	6.83	<.001
Age(5:7)	-0.86	-1.68	-0.03	.98
Age(children:adults)	-3.70	-5.12	-2.30	>.99
Voice	-1.20	-2.21	-0.19	.99

Word order	-0.08	-0.37	0.24	0.69
Matching	-0.95	-1.24	-0.65	>.99
Age(5:7)*Voice	-0.27	-1.13	0.60	.74
Age(5:7)*Word order	0.00	-0.26	0.26	.49
Age(5:7)*Matching	-0.05	-0.29	0.20	.64
Age(children:adults)*Voice	0.18	-1.23	1.62	.41
Age(children:adults)*Word order	0.24	-0.20	0.67	.14
Age(children:adults)*Matching	-0.55	-0.98	-0.12	.99
Voice*Word order	0.25	-0.05	0.56	.05
Voice*Matching	-0.10	-0.39	0.20	.64
Word order *Matching	-0.75	-1.05	-0.45	>.99
Age(5:7)*Voice*Word order	-0.24	-0.49	0.01	.97
Age(5:7)*Voice*Matching	0.16	-0.09	0.42	.10
Age(5:7)*Word order*Matching	0.08	-0.16	0.33	.26
Age(children:adults)*Voice*Word order	0.21	-0.22	0.63	.17
Age(children:adults)*Voice*Matching	0.37	-0.05	0.79	.04
Age(children:adults)*Word order* Matching	-0.48	-0.92	-0.06	.98
Voice*Word order*Matching	-0.10	-0.40	0.20	.76
Age(5:7)*Voice*Word order*Matching	-0.04	-0.29	0.21	.64
Age(children:adults)*Voice*Word order*Matching	0.04	-0.39	0.47	.43

3.3. Discussion

We used a self-paced listening and a picture verification task to check whether Tagalog-

speaking children use word order and/or morphosyntactic markers on the verb and the noun for thematic role assignment. We also tested adults as control participants. We first summarize and discuss the results from the picture verification task before coming to the results of the self-paced listening task. As expected, the adults showed high accuracy in all the conditions without large effects of the experimental manipulations. However, it is noteworthy that their accuracy in the patient-initial match condition was lower in the agent voice than in the patient voice. The same effect was found in children. In addition, children were more accurate in rejecting agent-initial mismatch sentences in the patient voice compared to the agent voice. An effect of word order was observed only in the children's data, with higher rates of correct acceptances for agent-initial compared to patient-initial sentences but this agent-initial advantage was only obtained in the agent voice. Our analysis against chance level showed larger differences across the age groups. The adults scored above chance in all conditions, while the 7-year-olds performed at chance level in the agent initial mismatch condition and above chance in all other conditions. The picture for the 5-year-olds was more differentiated with below chance performance in the agent voice agent-initial mismatch condition, chance performance in the agent voice patient-initial match and the patient voice agent-initial mismatch condition, and above chance in the remaining conditions.

In the conditions predicted to be low in accuracy given a high reliance on word order, namely agent-initial mismatch and patient-initial match, children showed higher accuracy in the patient voice compared to the agent voice. This result is similar to Segalowitz & Galang's (1978) findings from using an act-out task and indicates that children relied more strongly on word order for thematic role assignment in the agent voice than in the patient voice. Additionally, children were generally more accurate in correctly accepting agent-initial than patient-initial sentences in the agent voice. This

agent-initial advantage was not observed in the patient voice because children scored high for both word orders in this condition.

In the agent voice, 5-year-old children had high accuracy in the agent-initial match condition but showed below chance level performance in the agent-initial mismatch condition. These results indicate that 5-year-olds consistently interpreted the first mentioned noun as the agent regardless of the nominal morphology. As regards the patient-initial condition, they had higher accuracy in the mismatch compared to the match, which means that they judged the sentence as incorrect, whenever the patient was mentioned first, regardless of the noun markers. When word order and the morphosyntactic markers indicated different agents (mismatch conditions), the 5-year-olds relied on word order for thematic role assignment. However, the patient-initial condition results indicate that the children did not solely rely on word order. If they did, they would have performed below chance level instead of showing chance level performance in the match condition. The children may have had a *yes* or *match* bias, as observed in four-year-old Japanese and Vietnamese children (Okanda & Itakura 2008), thus showing an increased accuracy in the patient-initial match condition. However, this bias does not explain above chance accuracy in the patient-initial mismatch condition, as this result demonstrates that the children were not generally hesitant to give a *mismatch* answer. It is possible that when 5-year-olds encountered a patient following an agent voice inflected verb, which was unexpected when they adhere to a word order strategy, they resorted to guessing.

In the patient voice, the 5-year-olds scored above chance in both the agent-initial and patient-initial match conditions, which also shows that they did not rigidly use a word order strategy. They also scored above chance in the patient-initial mismatch condition, showing that they used the patient voice marker on the verbs and the marker

on the noun to correctly reject the patient-initial mismatch sentences. However, they scored at chance level in the agent-initial mismatch condition showing that word order affects their sentence interpretation also in the patient voice.

Compared to the 5-year-olds, the 7-year-olds showed above chance level performance in all of the conditions except for the agent voice agent-initial mismatch condition, for which they performed at chance. This condition would be below chance given a rigid word order strategy, demonstrating that the 7-year-olds' performance was affected by word order and the morphosyntactic markers. However, chance level performance in the agent-initial mismatch condition also demonstrates that 7-year-old learners of Tagalog still did not show adult-like use of the morphosyntactic markers for thematic role assignment.

Regarding the online measure, adults showed longer first noun phrase listening times for agent-initial sentences when the marker on the verb and the noun did not match what was depicted on the picture (mismatch conditions), compared to when the markers matched the scene in the picture (match conditions), thus providing evidence that they incrementally processed the morphosyntactic markers. Additionally, in the match condition, listening times for patient-initial sentences were longer compared to agent-initial sentences, which indicates that the adults did not expect the patient as the first noun phrase. This result is in line with the finding from Sauppe's (2016) study which demonstrated that adult Tagalog-speakers have a strong expectation that agents occur immediately after the verb.

In the patient voice, children had longer listening times for the mismatch compared to the match condition. This finding implies that children, similar to the adults, recognized the difference between a mismatch in the interpretation of the verb and noun markers and the visual stimulus. Thus, the children must have incrementally

processed the information given by these morphosyntactic markers. However, an effect of matching was not observed in the agent voice. In addition, children's listening times for the first noun phrase were longer for patient-initial sentences compared to agent-initial sentences in the match condition. This result implies that like adults, children have an agent-initial preference in both voices.

The listening times and the accuracy data both suggest that children are better able to make use of the morphosyntactic markers in the patient voice than in the agent voice. The better performance in the patient voice cannot be attributed to the fact that it was a between-subject variable. The 5-year-olds and 7-year-olds in both agent and patient voice versions of the experiment were enrolled in Kindergarten and Grade 2, respectively. However, during the data collection, the children who participated in the patient voice version actually had been enrolled for only a month; while those children who were given the agent voice version were on the last month of the school year. Despite the fact that the children in the agent voice version had more experience in school, they still showed poorer comprehension compared to the children in the patient voice.

4. GENERAL DISCUSSION

We investigated why children find non-canonical sentences difficult by testing the claims of the frequency account, the Competition Model, and the incremental processing account in Tagalog. We used a combination of online and offline tasks to investigate whether Tagalog-speaking children rely on word order and/or on the morphosyntactic markers for thematic role assignment.

In Study 1, the analysis of the child-directed speech corpus showed that the morphosyntactic cue—voice-marking on the verb and noun marker—has a higher validity in Tagalog compared to the word order cue. In addition, we found that patient

voice sentences are more frequent in the child-directed speech input compared to agent voice sentences; and that sentences in both voices are predominantly agent-initial.

In Study 2, we tested the claims of the different accounts using a self-paced listening and picture verification task. The listening times data showed children's processing of the morphosyntactic markers on the verb and the noun, while the accuracy data evaluated children's comprehension at the end of the sentence. We found that 5-year-olds showed more reliance on word order in the agent voice, and on the morphosyntactic markers in the patient voice. Seven-year-olds generally exhibited less reliance on word order compared to the 5-year-olds, but they still did not show consistent use of the morphosyntactic markers for thematic role assignment, which was exhibited by adults. In the patient voice, all age groups also showed processing of the voice-marking on the verb and the noun marking by the first noun phrase, as evidenced by longer listening times for the mismatch compared to the match condition. In contrast, in the agent voice, only adults showed evidence of processing the morphosyntactic markers by the first noun phrase. In the match condition, there were also longer listening times for patient-initial sentences compared to agent-initial sentences, showing an agent-initial preference for all age groups.

We now evaluate the three hypotheses introduced in the introduction on the basis of these results. First, our results do not fully support the claims of the Competition Model (MacWhinney 1987; MacWhinney & Bates 1989). The model predicts that when cues compete and indicate different agents, the cue with a higher validity will be used for thematic role assignment. Based on the results of Study 1, the morphosyntactic markers are more valid than word order as a cue to thematic role assignment in Tagalog, so children should acquire it early on. However, our results

indicate that children used the morphosyntactic markers in the patient voice but not in the agent voice, for which they relied on a word order strategy.

It can be argued that the corpus in Study 1 is too small for the cue validity calculations, because they were based on recordings of only three families, compared to six in other studies using the Competition Model framework (Chan, Lieven, & Tomasello 2009; Dittmar et al. 2008). However, the number of analyzed utterances with verbs in the current research is even higher than in the previous studies, as two recordings per family were used. Moreover, we did the calculations per family, and per session per family, and the results were comparable to the grand average which was presented in this paper. Our findings show that a cue with a higher validity (i.e., morphosyntactic markers) is not necessarily acquired earlier compared to a cue with lower validity.

Another argument can be that the availability of the word order cue should be calculated differently (Dittmar et al., 2008). If what matters is only the post-verbal position and not the positional relation between two noun phrases given the verb-initial canonical order of Tagalog, then even sentence fragments contain a word order cue. If these fragments are included in the counts for our corpus, then the word order cue's availability dramatically increases from 34% to 72%. In 87% of these utterances containing the word order cue, the agent occurred as the first noun phrase. The overall cue validity of word order then increases from 29% to 62%. With such a calculation, the validity of word order is similar to that of the morphosyntactic cue (62% to 63%), making it difficult to generate predictions for cue use. However, even when cue validity is calculated in this way, word order does not come out to have a higher validity than the morphosyntactic markers. Hence, cue validity still cannot explain children's reliance on a word order strategy when the two cues competed.

The incremental processing account (Trueswell & Gleitman 2004; 2007; Huang et al. 2013) claims that children can incrementally process early-arriving cues in the sentence, but have difficulties in revising their initial thematic role assignment when the later-arriving cues contradict the earlier cues. Moreover, there should be fewer processing issues when the cues are used to guide instead of revise an earlier interpretation (Trueswell et al. 2014). Because the morphosyntactic markers are given early in Tagalog sentences, the account predicts no difficulty even in non-canonical patient-initial sentences regardless of voice.

The children—like adults—did show evidence of incremental use of the patient voice marker on the verb and the marking on the noun, as they had longer listening times for the mismatching noun marker compared to the matching noun marker in the first noun phrase segment. However, if the problem with non-canonical sentences is only in revision as predicted by the incremental processing account, it is then puzzling why children were not able to use the agent voice marker on the verb which was also an early-arriving cue, much like the patient voice marker. The general advantage in accuracy for sentences in the patient voice compared to sentences in the agent voice is therefore not compatible to the predictions by the incremental processing account as in both constructions, the thematic role assignment is unambiguous from the occurrence of the first noun phrase in the sentence.

According to the frequency account (Demuth 1989; Gordon & Chafetz 1990; Kline & Demuth 2010), this asymmetry in performance between agent and patient voice is expected and due to the higher frequency of the patient voice in child-directed speech, as observed in Study 1. This better performance in the patient voice corroborates findings in languages with higher frequency of passives in the input which showed earlier passive acquisition (e.g., Alcock et al. 2011 for Kiswahili and Kigiriama; Allen

& Crago 1996 for Inuktitut; and Demuth 1989; Demuth et al. 2010; Kline & Demuth 2010 for Sesotho). Tagalog patient voice is comparable to passives in other languages, in which the patient is the subject of the sentence instead of the agent.

However, considering the frequency of the specific constructions that were used in our study shows that the result pattern does not exactly mirror frequency. Going back to the corpus that we analyzed in Study 1, we found the following frequencies in utterances with transitive sentences and at least one argument: 60% of these utterances were patient voice agent-initial, 27% agent voice agent-initial, 11% patient voice patient-initial, and 2% agent voice patient-initial. Based on these numbers, a purely frequency-based account would predict that children perform better in the patient voice agent-initial than in the agent voice agent-initial. In contrast, no differences in accuracy between these two conditions were observed in the children's data. Moreover, based on the frequency account, better performance would also be expected in patient voice agent-initial compared to the patient voice patient-initial sentences, but this prediction was also not supported by the data.

Overall, none of the factors that have been proposed to be relevant for children's problems in thematic role assignment can explain the result pattern of our study on its own. We suggest that both frequency and incremental processing can partly account for our data. First, the patient voice is overall more frequent, so children have more experience with the patient voice marker on the verb, and they become aware that they have to map this voice marker with the noun markers, namely that the *ang*-marked noun is the patient, and the *ng*-marked noun is the agent. As the self-paced listening data show, they can use this information immediately when they encounter the morphosyntactic information provided by the verb and the first noun in the sentence such that no revision of an initially incorrect assignment may be necessary for a correct

sentence interpretation. In contrast, children may not yet be fully familiar with the agent voice, so they resort to heuristics like a word order strategy when they encounter this voice marker on the verb. Given the fact, that—independent of the voice—agent-initial sentences are by far the most frequent construction in the input, it is not surprising that a word order heuristic has an effect on sentence interpretation. What is remarkable is that children follow this word order heuristic only selectively and that the rather complex system of morphosyntactic marking can override this heuristic at least in the more frequent voice. What remains an open issue is the cause of the general disadvantage for the agent voice compared to the patient voice. Further research is needed to investigate whether only the relatively low frequency or other structural properties of the agent voice makes this construction hard for children to acquire.

In conclusion, our research showed that even at the age of 7, Tagalog-speaking children have not yet fully mastered the use of the voice-marking on the verbs and the noun markers for assigning thematic roles in their language. It adds to the understanding of cross-linguistic and language-specific factors which affect children's acquisition of thematic role assignment, and shows that less-studied languages contribute in a relevant way to the study of children's sentence comprehension skills.

5. REFERENCES

Abbot-Smith, Kirsten & Ludovica Serratrice. 2013. Word order, referential expression, and case cues to the acquisition of transitive sentences in Italian. *Journal of Child Language* 42. 1–31.

Abbot-Smith, Kirsten & Heike Behrens. 2006. How known constructions influence the acquisition of other constructions: The German passive and future constructions. *Cognitive Science* 30. 995-1026.

Alcock, Katherine J, Kenneth Rimba & Charles RJC Newton. 2012. Early production of the passive in two Eastern Bantu languages. *First Language* 32(4). 459–78.

Aldridge, Edith. 2002. Nominalizaton and WH-movement in Seediq and Tagalog. *Language and Linguistics* 3(2). 393-426.

Allen, Shanley E. M. & Martha B. Crago. 1996. Early passive acquisition in Inuktitut. *Journal of Child Language* 23(1). 129–155.

Ammon, Mary Sue & Dan I. Slobin. 1979. A cross-linguistic study of the processing of causative sentences. *Cognition* 7(1). 3–17.

Audacity Team. 2015. Audacity(R): free audio editor and recorder (Version 2.1.0) [computer program]. http://audacity.sourceforge.net/ (1 February, 2016).

Barr, Dale J., Roger Levy, Christoph Scheepers & Harry J. Tily. 2013. Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language* 68(3). 255–278.

Bates, Elizabeth, Brian MacWhinney, Cristina Caselli, Antonella Devescovi, Francesco Natale & Valeria Venza. 1984. A cross-linguistic study of the development of sentence interpretation strategies. *Child Development* 55(2). 341.

Bever, Thomas G. 1970. The cognitive basis for linguistic structures. In. J. R. Hayes (ed.), *Cognition and the development of language*, 279–352. New York: Wiley.

Billings, Loren A. 2005. Ordering clitics and postverbal R-expressions in Tagalog: a unified analysis? In A. Carnie, H. Harley & S. A. Dooley (eds.), *Verb first: On the syntax of verb initial languages*, 303–339. Amsterdam: John Benjamins.

Brooks, Patricia J. & Michael Tomasello. 1999. Young children learn to produce passives with nonce verbs. *Developmental Psychology* 35(1). 29–44.

Buenaventura-Naylor, Paz. 1975. Topic, focus, and emphasis in the Tagalog verbal clause. *Oceanic Linguistics* 14. 12-79.

Chan, Angel, Elena Lieven & Tomasello, M. 2009. Children's understanding of the agent-patient relations in the transitive construction: Cross-linguistic comparisons between Cantonese, German, and English. *Cognitive Linguistics* 20(2). 267–300.

Coelho de Barros Pereira Rubin, Maraci. 2009. The passive in 3- and 4-year-olds. *Journal of Psycholinguistic Research* 38(5). 435–446.

Cooreman, Ann, Barbara A. Fox & Thomas Givón. 1984. The discourse definition of ergativity. *Studies in Language* 8(1). 1-34.

Demuth, Katherine. 1989. Maturation and the acquisition of the Sesotho passive. *Language* 65(1). 56–80.

Demuth, K., Francina Moloi & Malillo Machobane. 2010. 3-Year-olds' comprehension, production, and generalization of Sesotho passives. *Cognition* 115(2). 238–251.

de Villiers, Jill G. & Peter A. de Villiers. 1973. Development of the use of word order in comprehension. *Journal of Psycholinguistic Research* 2(4). 331–41.

Dittmar, Miriam, Kirsten Abbot-Smith, Elena Lieven & Michael Tomasello. 2008. German children's comprehension of word order and case marking in causative sentences. *Child Development* 79(4). 1152–1167.

Frankel, Daniel G., Marianne Amir, Etha Frenkel & Tali Arbel. 1980. A developmental study of the role of word order in comprehending Hebrew. *Journal of Experimental Child Psychology* 29(1). 23–35.

Forster, Kenneth I. & Jonathan C. Forster. 2014. DMDX (Version 5) [computer program]. Tucson: University of Arizona. http://www.u.arizona.edu/~kforster/dmdx/dmdx.htm (24 June, 2017.)

Gelman, Andrew, John B. Carlin, Hal S. Stern, David B. Dunson, Aki Vehtari & Donald B. Rubin 2014. *Bayesian data analysis,* 3rd edn. Chapman and Hall/CRC.

Gertner, Yael, Cynthia Fisher & Julie Eisengart. 2006. Learning words and rules: Abstract knowledge of word order in early sentence comprehension. *Psychological Science* 17(8). 684–691.

Gil, David. 2006. The acquisition of voice morphology in Jakarta Indonesian. In N. Gagarina & I. Gülzow (eds.), *The acquisition of verbs and their grammar: The effect of particular languages*, 201-227. Dordrecht: Springer.

Gordon, Peter & Jill Chafetz. 1990. Verb-based versus class-based accounts of actionality effects in children's comprehension of passives. *Cognition* 36(3). 227–254.

Guilfoyle, Eithne, Henrietta Hung & Lisa Travis. 1992. Spec of IP and spec of VP: Two subjects in Austronesian languages. *Natural Language and Linguistic Theory* 10. 375-414.

Hakuta, Kenji. 1977. Word order and particles in the acquisition of Japanese. *Papers and Reports on Child Language Development* 13. 117-127.

Himmelmann, Nikolaus P. 2004. Tagalog. In G. Booij, C. Lehmann, J. Mugdan, & S. Skopeteas (eds.), *Morphology. An international handbook on inflection and word formation*, 1473–1490. Berlin: de Gruyter.

Himmelmann, Nikolaus P. 2005. Tagalog. In K. A. Adelaar & N. P. Himmelmann (eds.), *The Austronesian languages of Asia and Madagascar*, 350-376. London: Routledge.

Hopper, Paul J. & Sandra A. Thompson. 1980. Transitivity in grammar and discourse. *Language* 56. 251 – 299.

Huang, Yi Ting, Xiaobei Zheng, Xiangzhi Meng & Jesse Snedeker. 2013. Children's assignment of grammatical roles in the online processing of Mandarin passive sentences. *Journal of Memory and Language* 69(4). 589–606.

Janssen, Bibi, Natalia Meir, Anne Baker & Sharon Armon-lotem. 2014. On-line comprehension of Russian case cues in monolingual Russian and bilingual Russian-Dutch and Russian-Hebrew children. In E. Grillo & K. Jepson (eds.), Proceedings of t*he 39th annual Boston University Conference on Language Development [BUCLD 39]*, 266-278. Boston: Cascadilla Press.

Kline, Melissa & Katherine Demuth. 2010. Factors facilitating implicit learning: The case of the Sesotho Passive. *Language Acquisition* 17(4). 220-234.

Kroeger, Paul R. 1993a. Another look at subjecthood in Tagalog. *Philippine Journal of Linguistics* 24(2). 1–15.

Kroeger, Paul R. 1993b. *Phrase structure and grammatical relations in Tagalog*. Stanford: CSLI Publications.

Kruschke, John K. (2011). Bayesian assessment of null values via parameter estimation and model comparison. *Perspectives on Psychological Science* 6(3). 299-312.

Lely, Heather K J van der. 1994. Canonical linking rules: forward versus reverse linking in normally developing and specifically language-impaired children. *Cognition* 51(1). 29–72.

Lindner, Katrin. 2003. The development of sentence-interpretation strategies in monolingual German-learning children with and without specific language impairment. *Linguistics* 41(2). 213–254.

MacWhinney, Brian. 1987. The competition model. In B. MacWhinney (ed.), *Mechanisms of language acquisition*, 73–136. Hillsdale, NJ: Erlbaum.

MacWhinney, Brian. 2000. *The CHILDES project: Tools for analyzing talk, 3rd edn.*. Mahwah, NJ: Lawrence Erlbaum Associates.

MacWhinney, Brian & Elizabeth Bates (eds.), 1989. *The cross-linguistic study of sentence processing.* Cambridge, NY: Cambridge University Press.

MacWhinney, Brian, Csaba Pleh & Elizabeth Bates. 1985. The development of sentence interpretation in Hungarian. *Cognitive Psychology* 17. 178–209.

Manueli, Maria Khristina S. 2010. A minimalist account of scrambling and word order in Tagalog: Testing its grammaticality. *Philippine Social Science Review (PSSR)* 62(2). 161– 195.

Marinis, Theodoros & Douglas Saddy. 2013. Parsing the passive: Comparing children with specific language impairment to sequential bilingual children. *Language Acquisition* 20(2). 155–179.

Marzan, Jocelyn C. 2013. *Spoken language patterns of selected Filipino toddlers and preschool children*. Diliman, Quezon City: University of the Philippines Diliman dissertation.

McDonald, Janet L. 1986. The development of sentence comprehension strategies in English and Dutch. *Journal of Experimental Child Psychology* 41(2). 317-335.

McElreath, Richard. 2016. *Statistical rethinking: A bayesian course with examples in R and Stan*. CRC Press.

Musolino, Julien & Jeffrey Lidz. 2006. Why children aren't universally successful with quantification. *Linguistics* 44. 817-852.

Nicenboim, Bruno & Shravan Vasishth. 2016. Statistical methods for linguistic research: Foundational Ideas-Part II. *arXiv preprint*. arXiv:1602.00245v1

Okanda, Mako & Shoji Itakura. 2008. Children in Asian cultures say yes to yes–no questions: Common and cultural differences between Vietnamese and Japanese children. *International Journal of Behavioral Development* 32(2). 131-136.

Omaki, Akira, Imogen Davidson White, Takuya Goro, Jeffrey Lidz & Colin Phillips. 2014. No fear of commitment: Children's incremental interpretation in English and Japanese wh-questions. *Language Learning and Development* 10. 206–233.

Pye, Clifton & Pedro Quixtan Poz. 1988. Precocious passives (and antipassives) in Quiche Mayan. *Papers and Reports on Child Language Development* 27. 71–80.

R Core Team. 2016. R: A language and environment for statistical computing (Version 3.2.5) [computer program]. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/ (24 June, 2017.)

Riesberg, Sonja & Beatrice Primus. 2015. Agent prominence in symmetrical voice languages. *STUF - Language Typology and Universals* 68. 551–564.

Sauppe, Sebastian. 2016. Verbal semantics drives early anticipatory eye movements during comprehension of verb-initial sentences. *Frontiers in Psychology* 7:95.

Schachter, Paul. 2015. Tagalog. In T. Kiss & A. Alexiadou (eds.), *Syntax—Theory and analysis: An international handbook. Handbooks of Linguistics and Communication Science*, vol. 42/3, 1658–1676. Berlin: Mouton de Gruyter.

Schachter, Paul & Fe T. Otanes. 1972. *Tagalog reference grammar*. Berkeley: University of California Press.

Segalowitz, Norman S. & Rosita G. Galang. 1978. Agent-patient word-order preference in the acquisition of Tagalog. *Journal of Child Language* 5. 47–64.

Slobin, Dan I. & Thomas G. Bever. 1982. Children use canonical sentence schemas: A crosslinguistic study of word order and inflections. *Cognition* 12. 229–65.

Sorensen, Tanner & Shravan Vasishth. 2016. Bayesian linear mixed models using Stan: A tutorial for psychologists, linguists, and cognitive scientists. *The Quantitative Methods for Psychology* 12(3). 175–200.

Stan Development Team. 2016. RStan: The R interface to Stan. R package version 2.14.1. http://mc-stan.org/ (12 October, 2017.)

Staroń, Malgorzata & Michèle Kail. 2004. Off-line sentence comprehension in Polish monolinguals: developmental study based on the Competition Model. *Psychology of Language and Communication* 8(1). 63–70.

Suzman, Susan M. 1987. Passives and prototypes in Zulu children's speech. *African Studies* 46(2). 241–254.

Tager-Flusberg, Helen. 2008. Sentence comprehension in autistic children. *Applied Psycholinguistics* 2(1). 5-24.

Tanaka, Nozomi, William O'Grady, Kamil Deen, Cha-Eun Kim, Ryoko Hattori, Ivan Paul M. Bondoc & Jennifer U. Soriano. 2015. Split focus preferences in Tagalog: Evidence from child language. In A. Camp, Y. Otsuka, C. Stabile & N. Tanaka (eds.), *AFLA 21: Proceedings of the 21st Annual Meeting of the Austronesian Formal Linguistics Association*, 279–288. Canberra: Asia-Pacific Linguistics.

Trueswell, John C. & Lila R. Gleitman. 2004. Children's eye movements during listening: Evidence for a constraint based theory of parsing and word learning. In J. Henderson & F. Ferreira (eds.), *Interface of language, vision, and action: Eye movements and the visual world*, 319-346. New York: Psychology Press.

Trueswell, John C. & Lila R. Gleitman. 2007. Learning to parse and its implications for language acquisition. In G. Gaskell (ed.) *Oxford handbook of Psycholinguistics*. Oxford: Oxford University Press.

Trueswell, John C., Daniel Kaufman, Alon Hafri & Jeffrey Lidz. 2012. Development of parsing abilities interacts with grammar learning: Evidence from Tagalog and Kannada. In A.K. Biller, E. Y. Chung, & A. E. Kimball (eds.), *Proceedings of the 36th Annual Boston University Conference on Language Development [BUCLD 36]*, 620-632. Somerville, MA: Cascadilla Press.

Trueswell, John C., Irina Sekerina, Nicole M. Hill & Marian L. Logrip. 1999. The kindergarten-path effect: Studying on-line sentence processing in young children. *Cognition* 73(2). 89–134.

Vasilyeva, Marina, Janellen Huttenlocher & Heidi Waterfall. 2006. Effects of language intervention on syntactic skill levels in preschoolers. *Developmental Psychology* 42(1). 164-174.

Appendix A

List of Experimental Sentences

Item	Condition	Sentence
1. *Hila* 'Pull'		
1.1 'The cow is pulling a pig every morning in the muddy field.'		
	Agent voice Agent-initial	*Humihila ang baka tuwing umaga ng baboy sa maputik na bukid.*
	Agent voice Patient-initial	*Humihila ng baboy tuwing umaga ang baka sa maputik na bukid.*
	Patient voice Agent-initial	*Hinihila ng baka tuwing umaga ang baboy sa maputik na bukid.*
	Patient voice Patient-initial	*Hinihila ang baboy tuwing umaga ng baka sa maputik na bukid.*
1.2. 'The pig is pulling a cow every morning in the muddy field.'		
	Agent voice Agent-initial	*Humihila ang baboy tuwing umaga ng baka sa maputik na bukid.*
	Agent voice Patient-initial	*Humihila ng baka tuwing umaga ang baboy sa maputik na bukid.*
	Patient voice Agent-initial	*Hinihila ng baboy tuwing umaga ang baka sa maputik na bukid.*
	Patient voice Patient-initial	*Hinihila ang baka tuwing umaga ng baboy sa maputik na bukid.*
2. *Silip* 'Peek'		
2.1. 'The pig is peeking at a cow today in the tidy house.'		
	Agent voice Agent-initial	*Sumisilip ang baboy ngayong araw ng baka sa maayos na bahay.*
	Agent voice Patient-initial	*Sumisilip ng baka ngayong araw ang baboy*

sa maayos na bahay.

Patient voice Agent-initial *Sinisilip ng baboy ngayong araw ang baka sa maayos na bahay.*

Patient voice Patient-initial *Sinisilip ang baka ngayong araw ng baboy sa maayos na bahay.*

2.2. 'The cow is peeking at a pig today in the tidy house.'

Agent voice Agent-initial *Sumisilip ang baka ngayong araw ng baboy sa maayos na bahay.*

Agent voice Patient-initial *Sumisilip ng baboy ngayong araw ang baka sa maayos na bahay.*

Patient voice Agent-initial *Sinisilip ng baka ngayong araw ang baboy sa maayos na bahay.*

Patient voice Patient-initial *Sinisilip ang baboy ngayong araw ng baka sa maayos na bahay.*

3. *Sipa* 'Kick'

3.1. 'The dog is kicking a turtle this afternoon in the colorful garden.'

Agent voice Agent-initial *Sumisipa ang aso ngayong hapon ng pagong sa makulay na hardin.*

Agent voice Patient-initial *Sumisipa ng pagong ngayong hapon ang aso sa makulay na hardin.*

Patient voice Agent-initial *Sinisipa ng aso ngayong hapon ang pagong sa makulay na hardin.*

Patient voice Patient-initial *Sinisipa ang pagong ngayong hapon ng aso sa makulay na hardin.*

3.2. 'The turtle is kicking a dog this afternoon in the colorful garden.'

Agent voice Agent-initial *Sumisipa ang pagong ngayong hapon ng aso sa makulay na hardin.*

Agent voice Patient-initial *Sumisipa ng aso ngayong hapon ang pagong sa makulay na hardin.*

Patient voice Agent-initial *Sinisipa ng pagong ngayong hapon ang aso sa makulay na hardin.*

Patient voice Patient-initial *Sinisipa ang aso ngayong hapon ng pagong sa makulay na hardin.*

4. *Huli* 'Capture'

4.1. 'The turtle is capturing a dog every Saturday in the high mountain.'

Agent voice Agent-initial *Humuhuli ang pagong tuwing Sabado ng aso sa mataas na bundok.*

Agent voice Patient-initial *Humuhuli ng aso tuwing Sabado ang pagong sa mataas na bundok.*

Patient voice Agent-initial *Hinuhuli ng pagong tuwing Sabado ang aso sa mataas na bundok.*

Patient voice Patient-initial *Hinuhuli ang aso tuwing Sabado ng pagong sa mataas na bundok.*

4.2. 'The dog is capturing a turtle every Saturday in the high mountain.'

Agent voice Agent-initial *Humuhuli ang aso tuwing Sabado ng pagong sa mataas na bundok.*

Agent voice Patient-initial *Humuhuli ng pagong tuwing Sabado ang aso sa mataas na bundok.*

Patient voice Agent-initial *Hinuhuli ng aso tuwing Sabado ang pagong sa mataas na bundok.*
Patient voice Patient-initial *Hinuhuli ang pagong tuwing Sabado ng aso sa mataas na bundok.*

5. *Palo* 'Hit'
5.1. 'The mouse is hitting a chicken tonight in the dark street.'
Agent voice Agent-initial *Pumapalo ang daga ngayong gabi ng manok sa madilim na kalye.*
Agent voice Patient-initial *Pumapalo ng manok ngayong gabi ang daga sa madilim na kalye.*
Patient voice Agent-initial *Pinapalo ng daga ngayong gabi ang manok sa madilim na kalye.*
Patient voice Patient-initial *Pinapalo ang manok ngayong gabi ng daga sa madilim na kalye.*
5.2. 'The chicken is hitting a mouse tonight in the dark street.'
Agent voice Agent-initial *Pumapalo ang manok ngayong gabi ng daga sa madilim na kalye.*
Agent voice Patient-initial *Pumapalo ng daga ngayong gabi ang manok sa madilim na kalye.*
Patient voice Agent-initial *Pinapalo ng manok ngayong gabi ang daga sa madilim na kalye.*
Patient voice Patient-initial *Pinapalo ang daga ngayong gabi ng manok sa madilim na kalye.*

6. *Pasan* 'Give a piggyback ride'
6.1. 'The chicken is giving a mouse a piggy back ride every night in the tiny park.'
Agent voice Agent-initial *Pumapasan ang manok gabi-gabi ng daga sa maliit na parke.*
Agent voice Patient-initial *Pumapasan ng daga gabi-gabi ang manok sa maliit na parke.*
Patient voice Agent-initial *Pinapasan ng manok gabi-gabi ang daga sa maliit na parke.*
Patient voice Patient-initial *Pinapasan ang daga gabi-gabi ng manok sa maliit na parke.*
6.2. 'The mouse is giving a chicken a piggy back ride every night in the tiny park.'
Agent voice Agent-initial *Pumapasan ang daga gabi-gabi ng manok sa maliit na parke.*
Agent voice Patient-initial *Pumapasan ng manok gabi-gabi ang daga sa maliit na parke.*
Patient voice Agent-initial *Pinapasan ng daga gabi-gabi ang manok sa maliit na parke.*
Patient voice Patient-initial *Pinapasan ang manok gabi-gabi ng daga sa maliit na parke.*

7. *Kagat* 'Bite'
7.1. 'The monkey is biting a cat every day in the clean room.'
Agent voice Agent-initial *Kumakagat ang unggoy araw-araw ng pusa sa malinis na kwarto.*
Agent voice Patient-initial *Kumakagat ng pusa araw-araw ang unggoy*

sa malinis na kwarto.

Patient voice Agent-initial *Kinakagat ng unggoy araw-araw ang pusa sa malinis na kwarto.*

Patient voice Patient-initial *Kinakagat ang pusa araw-araw ng unggoy sa malinis na kwarto.*

7.2. 'The cat is biting a monkey every day in the clean room.'

Agent voice Agent-initial *Kumakagat ang pusa araw-araw ng unggoy sa malinis na kwarto.*

Agent voice Patient-initial *Kumakagat ng unggoy araw-araw ang pusa sa malinis na kwarto.*

Patient voice Agent-initial *Kinakagat ng pusa araw-araw ang unggoy sa malinis na kwarto.*

Patient voice Patient-initial *Kinakagat ang unggoy araw-araw ng pusa sa malinis na kwarto.*

8. *Tira* 'Shoot'

8.1. 'The cat is shooting a monkey this Monday in the shallow river.'

Agent voice Agent-initial *Tumitira ang pusa ngayong Lunes ng unggoy sa mababaw na ilog.*

Agent voice Patient-initial *Tumitira ng unggoy ngayong Lunes ang pusa sa mababaw na ilog.*

Patient voice Agent-initial *Tinitira ng pusa ngayong Lunes ang unggoy sa mababaw na ilog.*

Patient voice Patient-initial *Tinitira ang unggoy ngayong Lunes ng pusa sa mababaw na ilog.*

8.2. 'The monkey is shooting a cat this Monday in the shallow river.'

Agent voice Agent-initial *Tumitira ang unggoy ngayong Lunes ng pusa sa mababaw na ilog.*

Agent voice Patient-initial *Tumitira ng pusa ngayong Lunes ang unggoy sa mababaw na ilog.*

Patient voice Agent-initial *Tinitira ng unggoy ngayong Lunes ang pusa sa mababaw na ilog.*

Patient voice Patient-initial *Tinitira ang pusa ngayong Lunes ng unggoy sa mababaw na ilog.*

9. *Sagip* 'Rescue'

9.1. 'The turtle is rescuing a monkey this afternoon in the shallow river.'

Agent voice Agent-initial *Sumasagip ang pagong ngayong hapon ng unggoy sa mababaw na ilog.*

Agent voice Patient-initial *Sumasagip ng unggoy ngayong hapon ang pagong sa mababaw na ilog.*

Patient voice Agent-initial *Sinasagip ng pagong ngayong hapon ang unggoy sa mababaw na ilog.*

Patient voice Patient-initial *Sinasagip ang unggoy ngayong hapon ng pagong sa mababaw na ilog.*

9.2. 'The monkey is rescuing a turtle this afternoon in the shallow river.'

Agent voice Agent-initial *Sumasagip ang unggoy ngayong hapon ng pagong sa mababaw na ilog.*

Agent voice Patient-initial *Sumasagip ng pagong ngayong hapon ang unggoy sa mababaw na ilog.*

Patient voice Agent-initial *Sinasagip ng unggoy ngayong hapon ang pagong sa mababaw na ilog.*
Patient voice Patient-initial *Sinasagip ang pagong ngayong hapon ng unggoy sa mababaw na ilog.*

10. *Gamot* 'Cure'
10.1. 'The money is curing a turtle this Monday in the clean room.'
Agent voice Agent-initial *Gumagamot ang unggoy ngayong Lunes ng pagong sa malinis na kwarto.*
Agent voice Patient-initial *Gumagamot ng pagong ngayong Lunes ang unggoy sa malinis na kwarto.*
Patient voice Agent-initial *Ginagamot ng unggoy ngayong Lunes ang pagong sa malinis na kwarto.*
Patient voice Patient-initial *Ginagamot ang pagong ngayong Lunes ng unggoy sa malinis na kwarto.*
10.2. 'The turtle is curing a monkey this Monday in the clean room.'
Agent voice Agent-initial *Gumagamot ang pagong ngayong Lunes ng unggoy sa malinis na kwarto.*
Agent voice Patient-initial *Gumagamot ng unggoy ngayong Lunes ang pagong sa malinis na kwarto.*
Patient voice Agent-initial *Ginagamot ng pagong ngayong Lunes ang unggoy sa malinis na kwarto.*
Patient voice Patient-initial *Ginagamot ang unggoy ngayong Lunes ng pagong sa malinis na kwarto.*

11. *Pili* 'Choose'
11.1. 'The pig is choosing a chicken every morning in the muddy field.'
Agent voice Agent-initial *Pumipili ang baboy tuwing umaga ng manok sa maputik na bukid.*
Agent voice Patient-initial *Pumipili ng manok tuwing umaga ang baboy sa maputik na bukid.*
Patient voice Agent-initial *Pinipili ng baboy tuwing umaga ang manok sa maputik na bukid.*
Patient voice Patient-initial *Pinipili ang manok tuwing umaga ng baboy sa maputik na bukid.*
11.2. 'The chicken is choosing a pig every morning in the muddy field.'
Agent voice Agent-initial *Pumipili ang manok tuwing umaga ng baboy sa maputik na bukid.*
Agent voice Patient-initial *Pumipili ng baboy tuwing umaga ang manok sa maputik na bukid.*
Patient voice Agent-initial *Pinipili ng manok tuwing umaga ang baboy sa maputik na bukid.*
Patient voice Patient-initial *Pinipili ang baboy tuwing umaga ng manok sa maputik na bukid.*

12. *Tawag* 'Call'
12.1. 'The chicken is calling a pig every Saturday in the high mountain.'
Agent voice Agent-initial *Tumatawag ang manok tuwing Sabado ng baboy sa mataas na bundok.*
Agent voice Patient-initial *Tumatawag ng baboy tuwing Sabado ang*

manok sa mataas na bundok.

Patient voice Agent-initial *Tinatawag ng manok tuwing Sabado ang baboy sa mataas na bundok.*

Patient voice Patient-initial *Tinatawag ang baboy tuwing Sabado ng manok sa mataas na bundok.*

12.2. 'The pig is calling a chicken every Saturday in the high mountain.'

Agent voice Agent-initial *Tumatawag ang baboy tuwing Sabado ng manok sa mataas na bundok.*

Agent voice Patient-initial *Tumatawag ng manok tuwing Sabado ang baboy sa mataas na bundok.*

Patient voice Agent-initial *Tinatawag ng baboy tuwing Sabado ang manok sa mataas na bundok.*

Patient voice Patient-initial *Tinatawag ang manok tuwing Sabado ng baboy sa mataas na bundok.*

13. *Salo* 'Catch'

13.1. 'The cat is catching a dog tonight in the clean house.'

Agent voice Agent-initial *Sumasalo ang pusa ngayong gabi ng aso sa maayos na bahay.*

Agent voice Patient-initial *Sumasalo ng aso ngayong gabi ang pusa sa maayos na bahay.*

Patient voice Agent-initial *Sinasalo ng pusa ngayong gabi ang aso sa maayos na bahay.*

Patient voice Patient-initial *Sinasalo ang aso ngayong gabi ng pusa sa maayos na bahay.*

13.2. 'The dog is catching a cat tonight in the clean house.'

Agent voice Agent-initial *Sumasalo ang aso ngayong gabi ng pusa sa maayos na bahay.*

Agent voice Patient-initial *Sumasalo ng pusa ngayong gabi ang aso sa maayos na bahay.*

Patient voice Agent-initial *Sinasalo ng aso ngayong gabi ang pusa sa maayos na bahay.*

Patient voice Patient-initial *Sinasalo ang pusa ngayong gabi ng aso sa maayos na bahay.*

14. *Karga* 'Carry'

14.1. 'The dog is carrying a cat every night in the dark street.'

Agent voice Agent-initial *Kumakarga ang aso gabi-gabi ng pusa sa madilim na kalye.*

Agent voice Patient-initial *Kumakarga ng pusa gabi-gabi ang aso sa madilim na kalye.*

Patient voice Agent-initial *Kinakarga ng aso gabi-gabi ang pusa sa madilim na kalye.*

Patient voice Patient-initial *Kinakarga ang pusa gabi-gabi ng aso sa madilim na kalye.*

14.2. 'The cat is carrying a dog every night in the dark street.'

Agent voice Agent-initial *Kumakarga ang pusa gabi-gabi ng aso sa madilim na kalye.*

Agent voice Patient-initial *Kumakarga ng aso gabi-gabi ang pusa sa madilim na kalye.*

Patient voice Agent-initial	*Kinakarga ng pusa gabi-gabi ang aso sa madilim na kalye.*
Patient voice Patient-initial	*Kinakarga ang aso gabi-gabi ng pusa sa madilim na kalye.*

15. *Baril* 'Shoot'

15.1. 'The mouse is shooting a cow today in the tiny park.'

Agent voice Agent-initial	*Bumabaril ang daga ngayong araw ng baka sa maliit na parke.*
Agent voice Patient-initial	*Bumabaril ng baka ngayong araw ang daga sa maliit na parke.*
Patient voice Agent-initial	*Binabaril ng daga ngayong araw ang baka sa maliit na parke.*
Patient voice Patient-initial	*Binabaril ang baka ngayong araw ng daga sa maliit na parke.*

15.2. 'The cow is shooting a mouse today in the tiny park.'

Agent voice Agent-initial	*Bumabaril ang baka ngayong araw ng daga sa maliit na parke.*
Agent voice Patient-initial	*Bumabaril ng daga ngayong araw ang baka sa maliit na parke.*
Patient voice Agent-initial	*Binabaril ng baka ngayong araw ang daga sa maliit na parke.*
Patient voice Patient-initial	*Binabaril ang daga ngayong araw ng baka sa maliit na parke.*

16. *Habol* 'Chase'

16.1. 'The cow chases a mouse every day in the colorful garden.'

Agent voice Agent-initial	*Humahabol ang baka araw-araw ng daga sa makulay na hardin.*
Agent voice Patient-initial	*Humahabol ng daga araw-araw ang baka sa makulay na hardin.*
Patient voice Agent-initial	*Hinahabol ng baka araw-araw ang daga sa makulay na hardin.*
Patient voice Patient-initial	*Hinahabol ang daga araw-araw ng baka sa makulay na hardin.*

16.2. 'The mouse chases a cow every day in the colorful garden.'

Agent voice Agent-initial	*Humahabol ang daga araw-araw ng baka sa makulay na hardin.*
Agent voice Patient-initial	*Humahabol ng baka araw-araw ang daga sa makulay na hardin.*
Patient voice Agent-initial	*Hinahabol ng daga araw-araw ang baka sa makulay na hardin.*
Patient voice Patient-initial	*Hinahabol ang baka araw-araw ng daga sa makulay na hardin.*

Appendix B

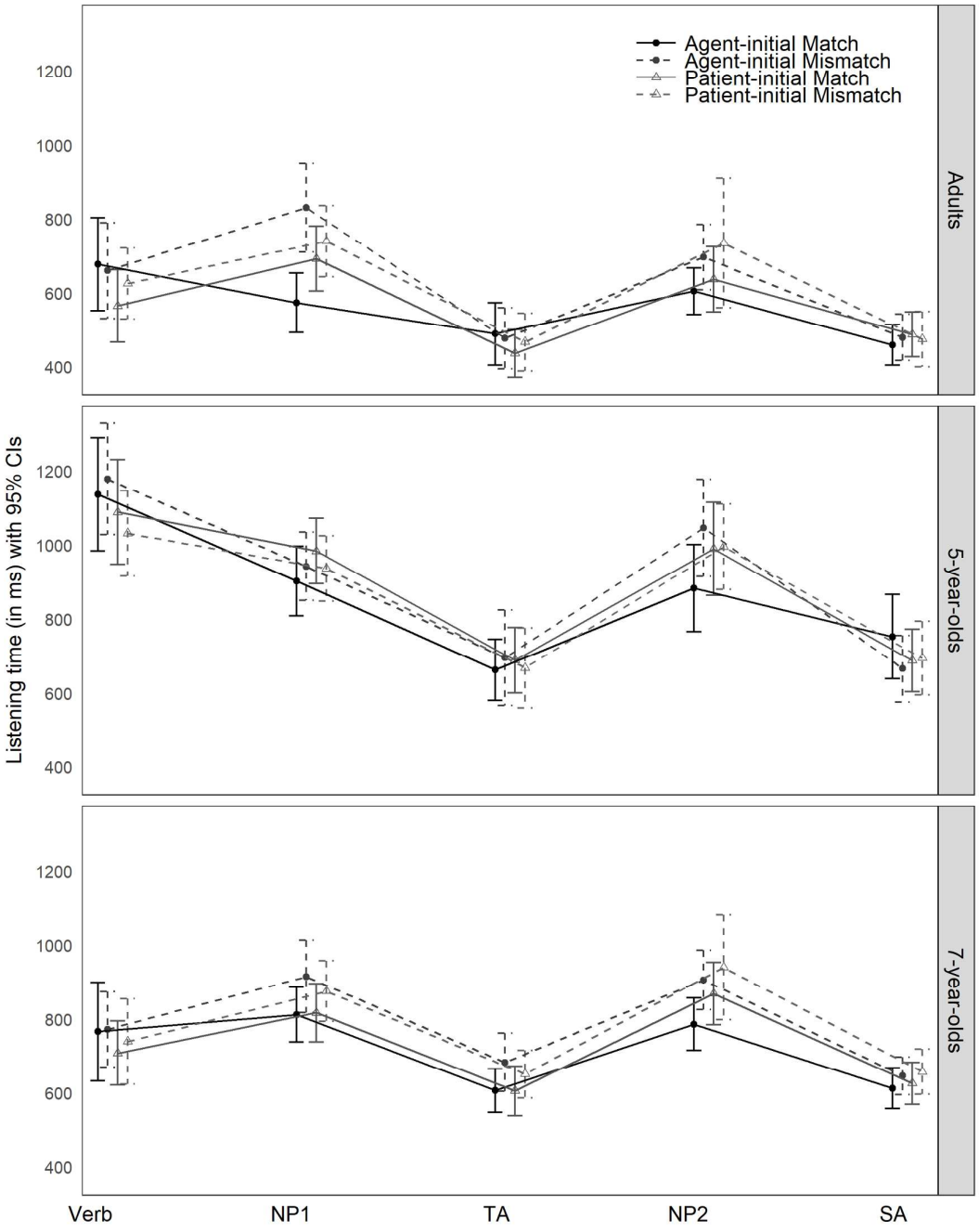

Figure 5. Mean listening times with 95% confidence intervals for each sentence fragment for word order and matching conditions per age group in the agent voice condition in Study 2.

Note. NP1 refers to the first noun phrase, TA to temporal adverb, NP2 to the second noun phrase and SA to spatial adverb.

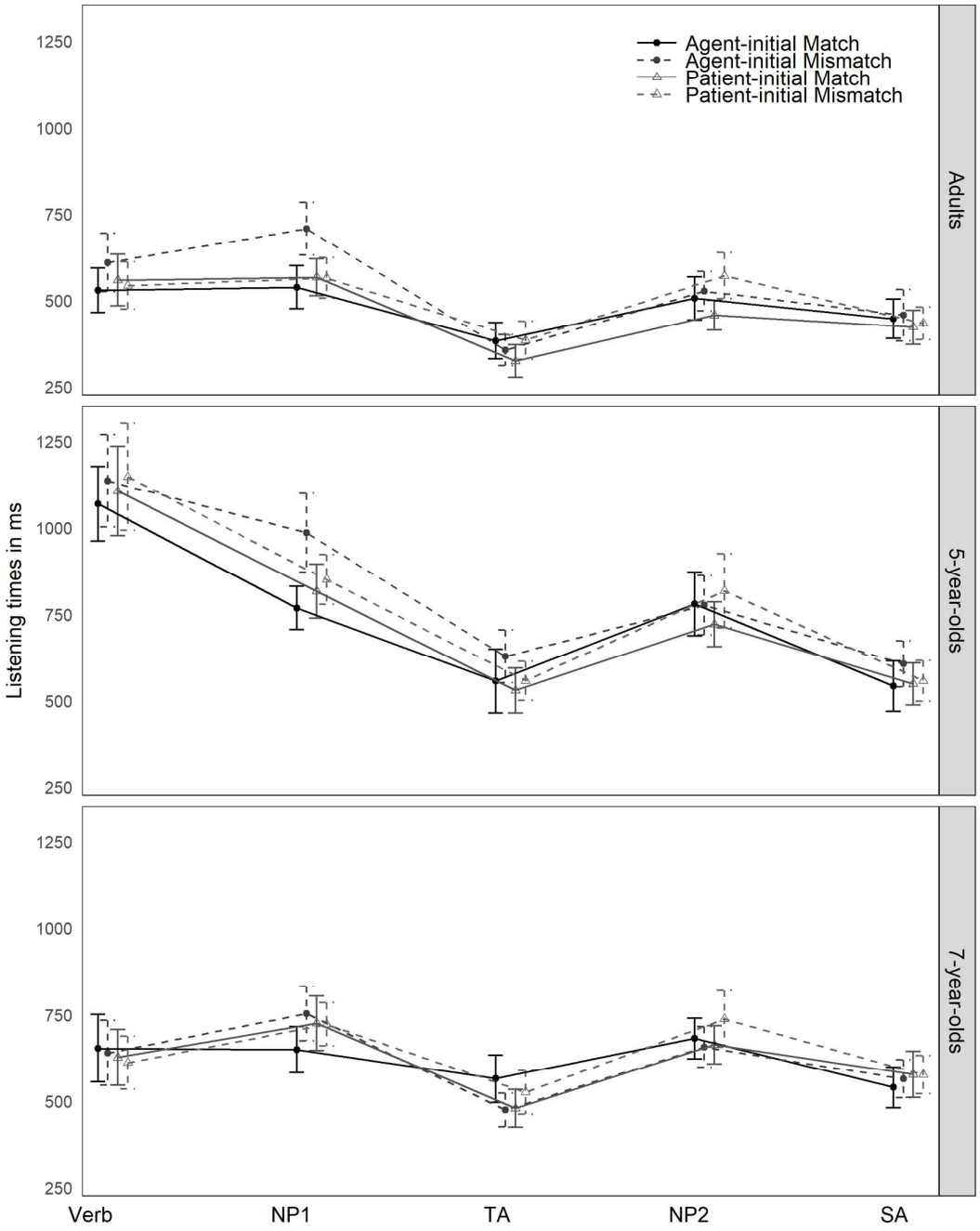

Figure 6. Mean listening times with 95% confidence intervals for each sentence fragment for word order and matching conditions per age group in the patient voice condition in Study 2.

Note. NP1 refers to the first noun phrase, TA to temporal adverb, NP2 to the second noun phrase and SA to spatial adverb.