

Predictive Use of Case Markers in German Children

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Languages differ along various dimensions with respect to how they mark argument relations. In about 35% of the world's languages, the subject appears prior to the verb, which is followed by the object. These languages tend to have strict word order and scarce morphosyntactic marking (Dryer, 2013a; Dryer, 2013b; Iggesen, 2005). In 42% of world's languages, on the other hand, the verb appears following the object. These languages tend to have flexible word ordering and rich morphosyntax (Dryer, 2013a; Dryer, 2013). It is plausible to think that in languages where the verb information appears relatively early in an utterance and where the location of the arguments is relatively fixed, the verb and the word order provide reliable information with respect to the thematic role of the arguments during the course of online interpretation; whereas in verb-final languages with flexible word order, morphosyntax might be more reliable in understanding the event structure revealed in an utterance.

Indeed, what we know from adult parsing is in line with this expectation. We know that English-speaking adults are likely to treat the first noun as the agent and generate anticipations about the rest of the utterance on the basis of the semantic and syntactic information provided by the verb (Boland & Tanenhaus, 1991; Trueswell, Tanenhaus & Garnsey, 1994; Altmann & Kamide, 1999). Japanese-speaking adults are more likely to use the case markers on the nouns to determine the role of this argument in the utterance and to generate predictions about the argument structure to unfold (Kamide, Altmann, & Haywood, 2003). In languages like German, on the other hand, there is no dominant pattern with respect to whether the verb appears clause-initially or clause-finally in an utterance (Dryer, 2013a; Comrie, 2009). It is verb-initial in simple matrix clauses and verb-final in embedded clauses. Furthermore, in

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German the case marking system is not as transparent as it is in languages like Turkish as it is conflated by number and gender information (Slobin, 1982). German-speaking adults have been reported to show an effect of surprisal in the form of biphasic N400/P600 effects upon encountering object-initial sentences (Frisch & Schlesewsky, 2005; Brauer, Anwander, Perani, & Friederici, 2013) and they have been reported to combine the verb information with the case marking information to be able to predict the second upcoming argument in an utterance (Kamide, Scheepers, & Altmann, 2003). Thus, a moral from these studies is that the basis for thematic prediction varies cross-linguistically so some cues might be more opportunistically used in some languages than others.

How about children? We know that from early ages onward, children start relying on word order and on heuristics treating the first argument as the agent (Slobin & Bever, 1982). They also use the semantic and syntactic information provided by the verb to create anticipations about the rest of the event structure (Nation, Marshall, & Altmann, 2003; Swingley, Pinto & Fernald, 1999, Borovsky, Elman & Fernald, 2012; Thothathiri & Snedeker, 2008; Mani & Hueting, 2012), and to resolve syntactic ambiguities (Trueswell, Sekerina, Hill & Logrip, 1999; Snedeker & Trueswell, 2004). But do they use case markers for the interpretation and prediction of thematic roles?

We address two specific hypotheses that expect young children to fail to use case marking cues during spoken language interpretation until age 6 or 7. According to late abstraction accounts, children's initial representation lacks any abstraction about possible semantic categories (doer/agent or undergoer/patient) so their initial representations are constructed around individual verbs to be able to decode thematic structure in an utterance (Tomasello, 1992; 1999; Akhtar & Tomasello, 1997; Boyd & Goldberg, 2012; Savage, Lieven, Theakston & Tomasello, 2003). In other words, children initially form isolated thematic islands on the basis of individual verbs. For instance, they realize that the *kisser* appears prior to *kissing*, which is followed by the *kissee* whenever the word *kissing* appears in an utterance. Importantly, there is no generalization about semantic roles in these initial interpretations (such that the *kisser* is the *doer* of the action and the *kissee* is the *receiver* of the action). As children accumulate many of such verb islands, they gradually attain broad semantic abstractions. Only then do they begin to realize that their language always marks certain semantic roles in certain structural patterns (e.g., case markers, verbal morphemes, word order). Having no initial semantic representations lead to the late abstraction of syntactic rules, which is manifested as verb-based interpretation of the thematic roles and failure to integrate case markers until late in acquisition.

The second hypothesis, namely the Syntactic Maturation Hypothesis, predicts that children would fail interpreting non-canonical sentences due to the late maturation of their Left Inferior Frontal Gyrus (LIFG). There is more or less a consensus on the fact that LIFG, more specifically the dorsal fiber bundles that connect the temporal cortex to Broca's area, does not reach full maturation until age 7 or 8, both in terms of synaptic connections and speed of

neurotransmission and that this region is correlated with higher order cognitive skills (Perani, Saccuman, Scifo, Anwander, Spada, Baldoli, Poloniato, Lohmann, & Friederici, 2011). According to the Syntactic Maturation Hypothesis, LIFG and dorsal fibers connecting temporal cortex to Broca's area have a specific syntactic function that assigns meaning to dislocated noun phrases and their case markers. This predicts that children should fail to assign thematic roles on the basis of case markers in non-canonical sentences and they should rely on a heuristic treating the first noun as the agent until their LIFG reaches full maturation (Friederici, 2011).

Poor parsing abilities of German-speaking children in non-canonical sentences have been used as a major evidence for the hypotheses expecting late, word-order-dependent and verb-dependent interpretation of case markers. Dittmar, Abbot-Smith & Tomasello's (2008) study using act-out and picture selection tasks with novel verbs indicate that there is a stage in language acquisition where German children ignore case markers and rely on verb until 5 years of age and on word order until 7 years of age. Online studies with German-speaking children also confirmed this pattern. For instance, Schipke, Friederici, & Oberecker (2011) showed that children do not show adult-like biphasic N400/P600 ERP responses in double-object violations (i.e., in sentences where two consecutive noun phrases marked in the accusative case are presented). Similarly, German children did not show adult-like LIFG activations in object initial sentences in fMRI studies (Knoll, Obleser, Schipke, Friederici & Brauer, 2012).

The alternative hypothesis is that the child comes to the task of language acquisition with core semantic notions (agent, action, patient) and adultlike parsing abilities, which make it easier to realize the systematic patterns across utterances that mark these semantic notions structurally. This would result in early abstract mappings between syntactic features and semantic roles (Gertner, Fisher & Eisengart, 2006; Fisher, 2002; c.f., Pinker, 1984; Gleitman, 1990). This account would predict early and incremental interpretation of case marking independent of the verb and the word order cues.

A recent eye-tracking study with Turkish-speaking children showed that 4-year-olds are able to use the case marking for thematic interpretation in an incremental and predictive manner. Modeled on a study by Kamide, Scheepers, & Altmann (2003) with German-speaking adults, this study presented children with subject- and object-initial spoken utterances (SVO vs. OVS and SOV vs. OSV) and ambiguous visual scenes with three related referents. Children were able to use the accusative and the nominative case on the first noun to predict the identity of the upcoming noun after the verb in verb-medial structures (SVO and OVS) and prior to the verb in verb-final structures (SOV and OSV) (Özge, Küntay, & Snedeker, 2013; submitted). This was the first clear evidence for incremental and verb-independent interpretation of case and prediction in children. However, the question is whether the same pattern would hold for children acquiring languages like German. Not being a typical verb-final language, German has a less reliable case system and much stricter word order

compared to Turkish. Thus, German-speaking children might need the verb to be able to assign a provisional meaning to the case markers. Indeed, German-speaking adults in Kamide and colleagues' (2003) study were able to use the case markers predictively only after the verb became available so one might expect more reliance on the verb in German. Also, German-speaking children might rely more on word order rather than case markers in decoding the argument structure, which might be a more reliable cue in German compared to Turkish that allows freer variation in word ordering.

In this study we address whether German-speaking children (4;0-4;12 years old) can use the case marking on the first noun to anticipate the role of the second noun in verb-final sentences where the first noun has either has the nominative or accusative case (SOV vs. OSV). This allows us to test (i) whether children rely more on word order than case markers to understand the argument structure in German and (ii) whether they can interpret case markers independent of the verb information. If German-speaking four-year-olds presented similar patterns to those of Turkish-speaking children, this would further contribute to emerging evidence that children's failure to interpret non-canonical sentences cannot be due to the late maturation of complex syntactic processes or by late abstraction of semantic and syntactic categories.

1. Experiment

The present study was modeled on the second experiment of our recent visual-word eye-tracking study with Turkish-speaking four-year-old children (Özge, Küntay, & Snedeker, 2013; submitted). In that study, participants were shown a visual scene with three referents related in such a way that one of the referents could act both as an agent or as a patient depending on the event structure (e.g., a scene with *a rabbit*, *a fox*, and *a carrot*: where the rabbit could be the agent in an action it is engaged with the carrot, or it could be the patient in an action it is engaged with the fox) and their eye movements on this scene was analyzed in relation to spoken utterances in two conditions (e.g., SOV: *rabbit-Nom shortly there-Rel carrot-Acc eat-Fut* 'The rabbit will shortly eat the carrot over there' versus OSV: *rabbit-Acc shortly there-Rel fox-Nom eat-Fut* 'The fox over there will shortly eat the rabbit'). Children had significantly more agent looks in the accusative (object-initial: OSV) condition compared to the nominative condition (subject-initial: SOV) during the relativizer region (there-Rel), which is prior to the verb. This demonstrates that Turkish-speaking four year olds are able to interpret the case markers incrementally without any recourse to the verb to predict the role of the upcoming referent.

We used similar verb-final sentences (e.g., 'Der Hase wird im nächsten Moment den Kohl aufspüren' *rabbit-Nom will shortly cabbage-Acc hunt-Fut* vs. 'Der Hase wird im nächsten Moment der Fuchs aufspüren' *rabbit-Acc will shortly fox-Nom hunt-Fut*) for the present study to test whether German-speaking children are able to use case for thematic prediction or they rely more on the verb and the word order. If children are able to use the case marking on

the first noun to interpret that noun and to create anticipations about the role of the second noun, we should observe more agent looks in the accusative compared to the nominative condition. We expect to find the predictive effects most strongly prior to the second noun during the adverbial region (im nächsten Moment).

1.1. Method

Participants

Our participants were 20 German-speaking monolingual children with typical development (4;0-5;0 years). All participants were selected from the pool of the Language and Cognition Lab of the Bielefeld University and they were attending a kindergarten.

Stimuli

For the critical test items, we constructed verb-final mono-transitive simple sentences with two arguments, as in (1) and (2). The first argument was marked in the nominative case in the SOV order (nominative condition) and in the accusative case in the OSV order (accusative condition). To ensure that all sentences were verb-final without any embedding, we used an auxiliary ‘*wird*’, which automatically dislocated the verb to the sentence-final position.

(1) Nominative condition (SOV)

Der Hase	wird	im nächsten Moment	den Kohl	aufspüren
Nom rabbit	will	in the next moment	Acc cabbage	hunt out

‘The rabbit will shortly hunt out the cabbage.’

(2) Accusative condition (OSV)

Den Hase	wird	im nächsten Moment	der Fuchs	aufspüren
Acc rabbit	will	in the next moment	Nom fox	hunt out

‘The fox will shortly hunt out the rabbit.’

The stimuli were the same as the ones in the Turkish study, except that (i) some of the nouns were changed to make sure that all nouns had the masculine gender (e.g., we used *cabbage* instead of *carrot* for the scene that involved the rabbit and the fox) and (ii) we used an auxiliary followed by a time adverbial ‘*wird im nächsten Moment*’ prior to the second noun instead of a prenominal relativizer we used in Turkish. This combination of the auxiliary and the time adverbial provided a large enough time window between the first noun and the second noun, in which predictive effects of case might arise following the case marking on the sentence-initial noun.

There were 20 critical items (10 for each condition). There were 10 filler items including intransitive sentences with the simple and complex subjects, as in (3) and (4), respectively.

(3) Das Vogelei wird im nächsten Moment zerbrechen.
 'The bird's egg will break in a moment.'

(4) Die Ente die der Freund der Bieneist wird im nächsten Moment schwimmen.
 'The duck that is the bee's friend will swim in a moment.'

Each critical sentence was accompanied with a visual scene with three related referents (Figure 1): (i) the topic, the referent of the first noun in the sentence and thus the entity that the sentence is about (e.g., *rabbit*); (ii) the plausible agent (e.g., *fox*), an entity who could reasonably be the doer of some action in a transitive event; and (iii) the plausible patient (e.g., *cabbage*), an entity which could be affected by an action performed by the topic but is unlikely to act on the topic.

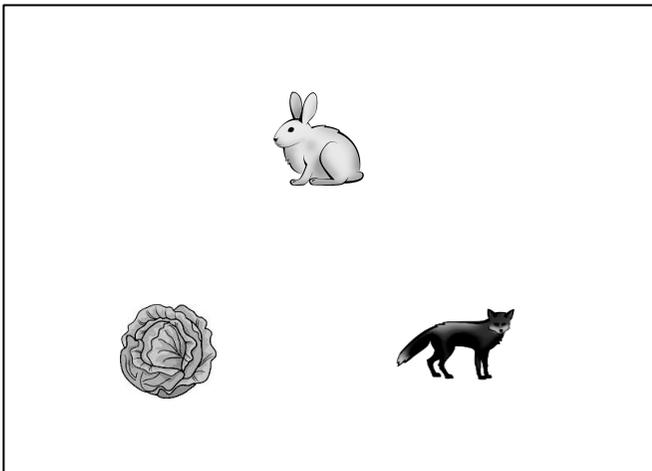


Figure 1: Sample visual display

A visual scene with three objects also accompanied each filler item. The pictures were prepared by a professional artist. All pictures were in color and at the resolution of 640 x 480 pixels. The location of each object on the screen was pseudorandomized such that the topic, the plausible agent, and the plausible patient appeared equally often in the three positions on the screen (upper right, upper left and lower middle).

Each item was followed by a comprehension check, where a picture of the event was depicted either correctly or incorrectly. For instance, for the sentence '*The fox will shortly hunt out the rabbit*', the correct picture depicted the fox hunting out the rabbit and the incorrect picture depicted the rabbit hunting out the cabbage. Participants judged these pictures as correct or incorrect in relation to the utterance they have heard.

A female native speaker of German (4th author) recorded the test sentences. There was no focus accent on the first noun to avoid the implication that this noun is topicalized or contrasted with another referent. We edited the sound files to control for the duration of the pauses between phrases. Each sound file was preceded by a 200-millisecond silence, the first noun was followed by a 300-millisecond silence, and there was a 1000-millisecond silence at the end of each sound file.

The case marking on the first noun was manipulated within subjects. Two counterbalanced lists were constructed so that each list contained 5 items in each condition and each item appeared in both conditions across the two lists. Each list was constructed so that two critical items from the same condition never occurred back to back. The same fillers were used across lists.

Procedure

Each participant sat in front of the screen of the Tobii T60 eye-tracker and they were calibrated using Tobii Studio. Each trial was gaze contingent so that participants were looking at the screen and being tracked throughout the study. If the participant left their seat during the task, the calibration was repeated. Before each item, three objects appeared on the screen and each was named as it appeared. On half of the trials, the end-sentence picture depicted the event described in the sentence, and on half of the trials it depicted some other event. Sentences from each condition were followed by incorrect picture on half of the trials. The participants were asked to look at the scene on the screen while listening to each sentence and then tell the experimenter whether the picture that appeared at the end of each item matched the sentence that they had heard. The participants' responses were coded by the experimenter during the session.

2. Results

Figure 2 shows how children's agent preference changed throughout the sentences in each condition. For these graphs, we synchronized the files at the onset of the speech stream and divided fixations into 100-ms time-windows until the sound file ended. We created a dependent variable *agent preference*, which was a binary variable revealing whether there were more looks to the potential agent or potential patient during a given time window. We calculated the agent preference by subtracting the number of samples in which our participants looked at the plausible patient from the number of samples in which our participants looked at the plausible agent.

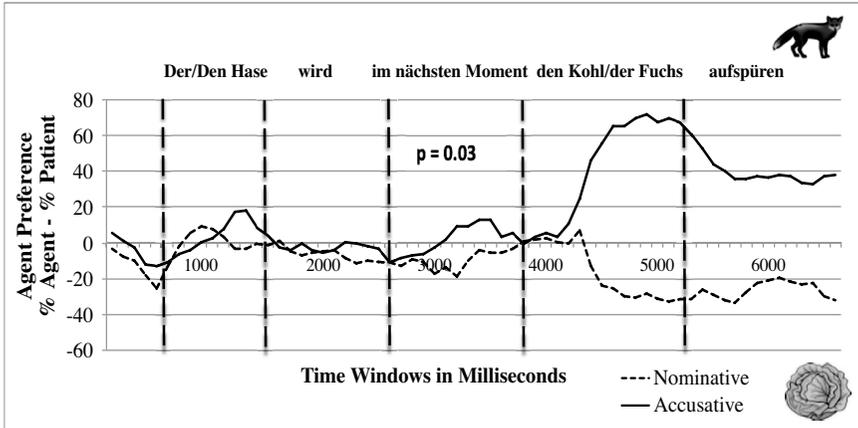


Figure 2: Agent preference in each time window in each condition

For statistical analysis, we conducted a Wilcoxon signed rank test for the adverbial region that preceded the second noun to find out whether the case marking had any effect on the agent preference. This revealed that our participants had a greater agent preference in the accusative condition (Med=18,4) compared to the nominative condition (Med = -12.9) [$W = 163$, $z = 2.2$, $p = .02$, $r = 4.5$], indicating that our participants were able to interpret the nominative and the accusative case incrementally to predict the upcoming argument independent of the word order and the verb information.

3. Discussion

The present study shows that German-speaking children use case markers incrementally to interpret the thematic role of the case-marked first argument and to create anticipations about the role of the second argument. In our experiment, we presented four-year-old children acquiring German with verb-final sentences in SOV and OSV orders and tracked their gaze patterns on a scene with three related referents. They shifted their looks significantly more often to the agent in the accusative (object-initial) compared to the nominative (subject-initial) condition. To our knowledge, this is the first clear evidence that German preschoolers interpret case incrementally for thematic prediction. More critically, they do so even in object-initial sentences and even before they encounter the verb. Their end-sentence comprehension was also very good, which suggests that they were able to hold on their meaning assignment that has arisen on the fly.

German-speaking children have been repeatedly shown to fail to comprehend case marking in non-canonical sentences in previous offline and online studies. They could not interpret case markers in sentences with unfamiliar verbs until age 5 (Dittmar et al., 2008) and in sentences that deviated from the canonical subject-initial orders until age 6 or 7 (Dittmar et al., 2008;

Schipke et al., 2011; Knoll et al., 2012). There were two strong interpretations of this data. Late abstraction accounts suggested that this pattern was an indication of absence of semantic abstraction of broad argument roles and late mapping between structural roles and argument roles (Tomasello, 1991; Ambridge & Lieven, 2011; Goldberg, 2006). Late syntactic neural maturation account related the German data to the late maturation of dorsal connections in LIFG, suggesting that these connections have a very specific syntactic function that assigns meaning/thematic roles to the dislocated noun phrases and their case markers (Brauer et al, 2013; Friederici, 2012). Although coming from two independent perspectives, both of these accounts had two crucial implications.

First, if children universally relied on verb meaning and word order, this would imply that children relied on parsing strategies that are better suited to verb-initial languages with strict word order, but not to verb-final languages. If interpretation were largely based on verbs then one would predict more effective online interpretation patterns in languages that present verb early in the utterance compared to verb-final languages. Children acquiring verb-final languages, on the other hand, would struggle, as they would have to keep un-integrated noun phrases and their case markers in memory until they have encountered the verb to be able to determine the role of these noun phrases. This would also mean that they had parsing strategies totally different from the ones that are available to adults. We know that adults are opportunistic in ranking the cues according to their reliability and string-based probabilities in line with the parsing model of their own language. Our study provides clear evidence that German children do not simply assign the first noun the agent role or wait until the verb to comprehend utterances and to interpret the case markers. Instead, they interpret morphosyntactic cues independent of the verb or word order. This means that they are not really different from adults or children of head-initial languages in terms of having an access to the language specific strategies.

Second, high reliance on verb and word order would mean that children do not have adult-like parsing mechanisms. We know that adults construct representation in an incremental and interactive manner. In other words, they do not wait until they encounter the verb or until the end of the sentence to integrate each incoming cue, and they draw on information coming from multiple sources/levels (e.g., phonological, syntactic, semantic, or pragmatic). Our results demonstrate that children also integrate available cues as soon as these cues become available and combine different sources of information such as visual context or world knowledge (e.g., rabbits eat cabbages and they are eaten by animals like foxes) to assign thematic roles and to predict the upcoming utterance. This indicates that they have adult-like incremental and interactive parsing mechanisms.

Our findings revealed that German children are just like Turkish-speaking children and adults (Özge, Küntay, & Snedeker, 2013; submitted) in interpreting case rapidly and spontaneously to integrate each noun phrase into the event structure even without any precise expectations about the kind of event that will

unfold in each utterance and even in non-canonical orders. This indicates that children access broad representations linking the available morphosyntactic cues to thematic roles, which is consistent with accounts suggesting that grammatical abstraction is early.

Our findings are not compatible with late abstraction and late neural syntactic maturation accounts. One reason why we have a more positive picture regarding German children's comprehension of case might be the fact that we depicted all referents in the visual context, which might have rendered the object initial sentences more natural. Another factor that contributed to this pattern might be the fact that we used verb-final utterances, which might have given children more time to use the sentence-initial case predictively prior to the verb. Finally, our sentences did not involve any embedding or nonce words, which might have reduced the overall complexity of the task. How about differences between our findings and those of the previous fMRI and the ERP studies? We suggest that processing difficulties reported in previous literature might be stemming from children's inability to revise initial parsing expectations. We know that children's limited inhibition skills prevent them from detecting errors or revising initial parsing choices (Choi & Trueswell, 2010). If children expected to hear a subject-initial utterance and if they failed to realize (on time) that the first argument was not actually the subject, this would lead to non-adultlike online (fMRI and ERP) effects. In other words, if we assume that P600 and LIFG activation actually reflected an effect of error detection, conflict resolution and re-analysis, if N400 modulation reflected the top-down activation of upcoming material, and if the processing difficulties reported in previous literature stems from children's inability to detect errors or revise initial parsing choices, then the patterns in previous fMRI and the ERP studies with German-speaking children would be explained.

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