Floating Quantifiers and Split NPs in German Syntax/Semantics Interface

Hiroyuki Izuo

Keywords: German word order, floating quantifiers, split NPs, categorial grammar, generalized quantifier, incremental parsing controlled by prediction

Abstract
Drawing on the semantic characterization of left periphery phenomena of German sentences, this paper investigates split constructions related to the "Floating Quantifier construction (FQ)" and the "split NP construction (SNP)," both of which often occur in German. The paper aims to provide a model which shows that differences in the syntactic characteristics of FQ and SNP cause differences in their semantics structures, and vice versa. The paper proposes a grammar formalism which can explain why the topicalized indefinite plural nouns that are quantified by keine ('no'), viele ('many'), or einige ('some') in the Mittelfeld of the sentence show quite different interpretation mechanisms from the topicalized definite NPs that can be quantified by alle ('all') in the Mittelfeld. In order to capture the difference between FQ and SNP, the paper applies combinatory rules of Categorial Grammar (CG), as these can be used to construct a framework of incremental parsing which reflects the recognition process of natural
language. By modifying the syntax/semantics interface in the CG-style, this article proposes prediction rules in order to explore the dynamics of semantic structures with regard to split constructions and their quantification.

1. Introduction

This paper focuses on the semantic properties of split constructions which are observed in German V2 sentences. The following examples show the phenomena of German split constructions which are composed of plural nouns in the left periphery of V2 sentences and their quantifiers, such as *alle* ('all'), *keine* ('no'), *viele* ('many') and *einige* ('some'), in the Mittelfeld of V2 sentences. The Mittelfeld is the field between the finite verb and the right-sentence bracket where non-finite verbal elements can appear.

(1) a. *Die Kaninchen*$_{acc}$ hat sie gestern *alle*$_{acc}$ gesehen.

The rabbits has she yesterday all seen

b. *Kaninchen*$_{acc}$ hat sie gestern *keine*$_{acc}$/viele$_{acc}$ gesehen.

Rabbits has she yesterday no/many seen

The split construction in which the quantifier *alle* ('all') in the Mittelfeld quantifies the fronted definite plural noun, for example *die Kaninchen* ('the rabbits') in (1a), is called a "Floating Quantifier construction" (FQ). On the other hand, the split construction in which quantifiers like *keine*, *viele* or *einige [welche]* in the Mittelfeld quantify the bare plural noun in the Vorfeld is called a "Split NP construction" (SNP); see (1b). The Vorfeld is the field before the finite verb in V2 sentences. The fronted definite noun in FQ is quantified by *alle* but cannot be quantified by *keine*, whereas the fronted bare plural noun in SNP cannot be quantified by *alle*. The paper investigates a variety of issues related to these syntactic/semantic properties of FQ and SNP.
The paper proceeds as follows. First, some basic characteristics of German split constructions are discussed from the viewpoint of the (in) definiteness of the plural nouns in the left periphery of V2 sentences and their quantifier expressions (Q-expressions), such as *alle, keine* and *viele* in the Mittelfeld. Next, combinatory rules of categorial grammar (CG) are introduced in order to provide model-theoretic interpretations of the split constructions. Then, prediction rules based on the combinatory rules are proposed and applied to explain differences related to left and right dislocation phenomena observed in FQ and SNP. Finally, the difference between the semantic structures of FQ and those of SNP is explored. In order to show why the process of accumulation of syntactic and semantic information of FQs differs from that of SNPs, left-to-right incremental parsing is proposed. On the basis of concrete analysis, the paper concludes that the difference between FQ and SNP is explicitly determined by predictive factors which are directed by the semantics structures of (in) definite plural nouns and their related Q-expressions.

2. Basic characteristics of FQs and Split NPs in German

In FQ, the definite plural NP appears not only in the Vorfeld of the V2 sentence, but also in the Mittelfeld, as shown in (2a,b). However, the bare plural noun in SNP can appear only in the Vorfeld, as in (3a,b). In contrast to the FQ-sentence (2b), the SNP-sentence (3b) is not acceptable, because the bare plural noun *Blumen* appears in the Mittelfeld. In FQ in (2c) shows that *alle* can move to the position of an adverb, whereas the acceptability of the SNP in (3c), in which *keine* appears in the position of an adverb, is not as high as it is in (3a). The SNP (3c) is therefore different from the FQ (2c).

(2) a. *Die Blumen* hat er gestern *alle* gegossen.
   The flowers has he yesterday all watered
   b. Er hat *die Blumen* gestern *alle* gegossen.
c. *Die Blumen hat er alle gestern gegossen.

(3) a. Blumen hat er gestern keine gegossen.

   Flowers has he yesterday no watered

b. *Er hat Blumen gestern keine gegossen.

c. ?Blumen hat er keine gestern gegossen.

Split construction in German has been investigated over the last four decades. In the framework of GB (for example, Fanselow, 1988; Sportiche, 1988; van Riemsdijk, 1989; Giusti, 1989; Merchant, 1996) and Head-Driven Phrase Structure Grammar (HPSG) (for example, Hinrichs and Nakazawa, 1994), the syntactic properties of FQ and SNP are discussed. For example, the approach to FQ proposed by Sportiche (1988) treats the quantifier as part of a nominal phrase: "the quantifier is claimed to be able to be stranded by movement of the associated nominal" (Merchant 1996, 180). However, Dowty and Brodie (1984) treat the quantifier alle in FQ as an adverb which can adjoin to VP. In order to show why alle in FQ is treated in one theory as part of the nominal phrase and in another theory as an adverbial quantifier, this paper adopts CG, because its combinatory rules can show that alle in FQ can be treated not only as an NP modifier, but also as a VP modifier. The research proposes a theory of FQ for German in order to explain about the relation between the anaphoric behavior of alle and the adverbial position of alle. This paper also clarifies some reasons why the word order and the semantic structure of FQ differ from those of SNP. For this purpose too, the paper adopts the combinatory rules of CG, as these give us an apparatus to construct a framework in which the syntactic and semantic structures can be accumulated in the course of the parsing of FQ and SNP. FQ can also appear in the partial VP fronting; see the following example (4). Such a partial VP fronting can also be analyzed by CG; see Izuo (2004).
(4) Gegossen hat er die Blumen gestern alle.

3. Combinatory rules and split constructions

In order to assign the model theoretic interpretation to each partial semantic structure of FQ and SNP, the research applies the semantics of CG to the analysis of FQ and SNP. This section introduces the syntax and semantics of CG in order to construct the semantic structures of FQ and SNP, because CG semantics and its typed lambda calculus facilitate a relatively straightforward analysis of semantic structures of expressions. The paper extends combinatory rules of CG to prediction rules in order to reflect the accumulation process of partial semantic information in the course of sentence recognition by humans. Extending the prediction rules proposed by Izuo (2004), the paper shows that even if the quantifier expression is separated from the fornted noun as observed in FQ and SNP, quantifier phrase like die Npl ... alle or Npl ... viele can be interpreted incrementally, that is from left to right in a piecemeal fashion.

3.1 Combinatory rules and their prediction mechanism

For formal semantic theory, some sorts of recursive rules are needed to construct complex expressions from base expressions. In CG (Moortgat, 1988; Buszkowski, 1988; Steedman 1988, 1996), syntactic categories are of two types: functor categories and argument categories. If X and Y are variables over a set of categories, X/Y is a functor category which looks for an argument category Y on its right and outputs the value category X, whereas the functor X\Y looks for the argument Y on its left. This functor-argument scheme of CG syntax corresponds to the typed lambda calculus of CG semantics which can refer to the objects in model-theoretic interpretation. The research applies the combinatory rules in (5) to parse the accumulation process of each partial semantic structure of FQ and SNP in
German. In (5), X:f Y:g → Z:v indicates that X:f and Y:g are reduced to Z:v, where X:f indicates that the syntactic category X is related to the semantic structure f.

(5) combinatory rules


2) Y:a X\Y:f → X:f(a).

b. Functional Composition: 1) X/Y:f Y/Z:g → X/Z: \(\lambda v.f(g(v))\), where Z:v.

2) Y\Z:g X\Y:f → X\Z: \(\lambda v.f(g(v))\), where Z:v.

c. Type-lifting: 1) X:a → Y/(Y\X): \(\lambda v.v(a)\), where Y\X:v.

2) X:a → Y\(Y/X): \(\lambda v.v(a)\), where Y/X:v.

d. Associativity: (X\Y)/Z:f → (X/Z)\Y: \(\lambda v_1 \lambda v_2.f(v_2)(v_1)\), where Y:v_1, Z:v_2.

e. Division: 1) X/Y:f → (X/Z)/(Y/Z): \(\lambda v_1 \lambda v_2.f(v_1(v_2))\), where Y/Z:v_1, Z:v_2.

2) X\Y:f → (X\Z)/(Y\Z): \(\lambda v_1 \lambda v_2.f(v_1(v_2))\), where Y\Z:v_1, Z:v_2.

In order to combine categories efficiently and incrementally, prediction rules can be derived from these combinatory rules as follows. The functor category C/C_1 predicts on its right an argument C_1 and at the same time a value C; see figure (7a) which shows that C is yielded if C/C_1 is applied to C_1. Based on this idea proposed by Izuo (2004), prediction rule (6a) can be derived from the combinatory rule (5a). The prediction rule (6b) is the case of a prediction that is derived from the composition rule (5b). The prediction rule (6c) indicates that the functor category C_2/C_3 can predict not only C_3 and C_2, but also another three categories: C_3/C_1, C_2/C_1 and C_1; see figure (7b). The prediction rule (6c) indicates that C_1 can predict C\C_1 on its right because of (5a-2) or C/C_1 on its left because of (5a-1), as shown in figures (7c1,c2). This prediction caused by (6c) can also be made by applying the type-lifting rule (5c), as shown in figures (7d1, d2). The division rule (5e) is applied to construct the prediction rule (6d), which says that the functor category C/C_1 can be divided by C_2 if the existence of C_2 is predicted, and therefore C/C_1
can predict two functor categories, $C_1/C_2$ and $C/C_2$; see figure (7e).

(6) Prediction rules

a. $C/C_1: \lambda c_1. h(c_1)$ predicts on its right the existence of its argument $C_1:c_1$ and at the same time the existence of its value $C:h(c_1)$, where $h(c_1) = c$.

b. $C_2/C_3:f$ can predict $C_3/C_1:g$, which further predicts $C_1:c_1$ on its right and at the same time the existence of two values, $C_2:f(g(c_1))$ and $C_2/C_1: \lambda c_1. f(g(c_1))$.

c. $C_1:c_1$ predicts $C\setminus C_1:f$ on its right as well as $C/C_1:f$ on its left and its value $C:f(c_1)$, where $f$ is $\lambda c_1. h(c_1)$, as shown in (6a).

d. $C/C_1:f$ can predict not only $C_1$ and $C$, but also $C/C_2$ and $C_1/C_2$, because $C/C_1$ can be divided by $C_2$ into $(C/C_2)/(C_1/C_2): \lambda v_1 \lambda v_2.f(v_1(v_2))$ where $v_1$ and $v_2$ are defined in $C_1/C_2:v_1$ and $C_2:v_2$ respectively.

(7) a. $\begin{array}{c} C \\ C/C_1 \rightarrow C_1 \end{array}$

b. $\begin{array}{c} C_2 \\ C_2/C_1 \rightarrow C_1 \\ C_2/C_3 \rightarrow C_3/C_1 \end{array}$

c1. $\begin{array}{c} C \\ C_1 \rightarrow C\setminus C_1 \end{array}$

c2. $\begin{array}{c} C \\ C/C_1 \leftarrow C_1 \end{array}$

d1. $\begin{array}{c} C \\ C/(C\setminus C_1) \rightarrow C\setminus C_1 \end{array}$

d2. $\begin{array}{c} C \\ C/C_1 \leftarrow C\setminus (C/C_1) \end{array}$
If prediction rule (6c) is applied to the category of the $Q_{FQ}$-expression *alle* in FQ, i.e. to $Q_{FQ}$, this $Q_{FQ}$ predicts on its left $QP/Q_{FQ}$, which is equal to $NP_{def,pl}$, where $QP$ is the category of the quantifier phrases which are composed of $NP_{def,pl}$ and $Q_{FQ}$. Therefore, $Q_{FQ}$ is equal to $QP\backslash NP_{def,pl}$, as shown in (8a), where '||' is the equal sign. This category is also guaranteed by (7d2); i.e. $Q_{FQ}$ can be type-lifted to $QP\backslash(QP/Q_{FQ})$, which is equivalent to $QP\backslash NP_{def,pl}$ because $QP/Q_{FQ}$ is $NP_{def,pl}$. See (8a) and (8b).

(8) a. $\quad QP \quad NP_{def,pl} \quad QP\backslash NP_{def,pl} \quad||\quad QP/Q_{FQ} \quad Q_FQ$  
   b. $\quad QP \quad QP\backslash(QP/Q_{FQ}) \quad Q_{FQ} \quad Q_{FQ}$

In the process of human speech recognition, each partial interpretation of constituents is accumulated incrementally, i.e. from left to right in a piecemeal fashion, even before the recognition of phrasal constituents is completed. In this recognition process there must be reasons why split constructions like FQ and SNP are used. The difference between FQ and SNP with regard to left and right dislocation phenomena must be determined by different manners of accumulation of meanings in the course of the recognition of FQ and SNP. This research explores the difference in the incremental accumulation process of each partial semantic structure which can be determined by each constituent of FQ and SNP.

3.2 Semantic structures of NP and VP
In this paper the choice is made to model the world as a set of individuals. The semantic type \(<e, t>\), used for example in Montague (1974), is a function from entities \(e\) to truth value \(t\); i.e., \(<e, t>\) is the type of one-place predicate that refers to a set of individuals. Because the German intransitive verb *schwimmen* ('swim') combines with a nominative \(\text{NP}_{\text{nom}}\) and constructs a sentence, *schwimmen* is a one-place verb, \(V^1\), and its meaning is a set of individuals who swim, where \(V^1\) is a category of the one-place verb. The semantic structure of *schwimmen* can be represented as \(\lambda x.\text{Schwimmen}(x)\), where \(\text{Schwimmen}\) is a one-place predicate constant of type \(<e, t>\) and \(x\) is a variable of type \(e\). The sentence \(V^0\) can be defined as a category of verb phrases whose complements are all saturated inclusive of the subject. Because German transitive verbs such as *lesen* ('read') combines with an accusative \(\text{NP}_{\text{acc}}\) and becomes \(V^1\), their category is represented as the two-place verb \(V^2\). The semantic structure of *lesen* is \(\lambda x_2 \lambda x_1\). \(\text{Lesen}(x_1, x_2)\) and its semantic type is \(<e, <e, t>>\), where \(\text{Lesen}\) is a two-place predicate constant. In Montague (1974), the semantic type of the noun phrase \(\text{NP}\) is defined as \(<<e, t>, t>\), which is known as a type of generalized quantifier. This paper applies Montague's generalized quantifier to the nominative noun phrase, \(\text{NP}_{\text{nom}}\). This category can be lifted to \(V^0|(V^0|\text{NP}_{\text{nom}})\), which is equal to \(V^0|V^1\) because of \(V^0|\text{NP}_{\text{nom}} = V^1\), where the vertical slash "|" indicates that the position of its argument is unspecified. As indicated in (9a), the nominative \(\text{NP}_{\text{nom}}\) *der Mann* ('the man') is translated into a function from a one-place predicate \(v^1\) to a formula \(v^0\). Concerning the other case-marked NPs like accusative \(\text{NP}_{\text{acc}}\), Izuo (2004) proposed semantic structures which are different from the generalized quantifier. If the type-lifting rule (5c) is applied, \(\text{NP}_{\text{acc}}\) is type-lifted to \(V^1|(V^1|\text{NP}_{\text{acc}})\), that is to \(V^1|V^2\) because of \(V^1|\text{NP}_{\text{acc}} = V^2\). As indicated in (9b), \(\text{NP}_{\text{acc}}\) like *ein Buch* acc ('a book') is translated into a function from a two-place predicate \(v^2\) into a one-place predicate \(v^1\). In (9), '
'Phon \(\Rightarrow\) Syn:Sem' indicates that an expression has a phonological form
Phon, a syntactic category Syn and a semantic structure Sem. In (9a,b), Mann and Buch are both one-place predicate constants.

(9) a. der Mann\textsubscript{nom} $\Rightarrow V^0|V^1 : \lambda v^1. \exists x[\forall w[\textit{Mann}(w) \leftrightarrow w=x] \land v^1(x)]$

b. ein Buch\textsubscript{acc} $\Rightarrow V^1|V^2 : \lambda v^2. \lambda x. \exists w[\textit{Buch}(w) \land v^2(x,w)]$

4. Interpretation of quantifiers

In FQ, the NP in the left periphery and its quantifier alle in the Mittelfeld show the definite-definite relation, as indicated in the sentence (10a). Alle is definite, because alle die Kinder (‘all the children’) can determine its denotation if the denotation of the definite noun die Kinder is already determined. This semantic feature of die and alle in FQ guarantees that the fronted definite NP can be quantified by alle in the Mittelfeld. In contrast, the fronted bare plural nouns and Q-expressions like keine, einige or viele in SNP show an indefinite-indefinite relation, as indicated in (10b). This semantic feature in SNPs guarantees that the fronted bare plural nouns can be quantified by keine, einige or viele in the Mittelfeld. If these relations are violated, as in (11a) and (11b), neither FQ nor SNP can be constructed.

(10) a. Die Kinder habe ich alle gesehen.

The children have I all seen


Children have I no/some/many seen

(11) a.*Blumen habe ich alle gekauft.

Flowers have I all bought

b.*Die Blumen habe ich keine gekauft.

definite indefinite
To analyze the plural nouns of FQ and SNP by applying formal semantics, the world is assumed to be a set $E$ of individuals. If the generalized quantifier theory (GQ) is applied, the denotation of *die* ('the') and *alle* ('all') can be classified in the same subset relation, i.e. $n \subseteq v^1$, as shown in (12a,b) where $v^1$ corresponds to the interpretation of the semantic structure $v^1$ of one-place verb $V^1$. In other words $v^1$ is a set of individuals, and therefore $v^1 \subseteq E$. $n$ is also a set of individuals denoted by the semantic structure $n$ of the noun $N$, i.e. $n \subseteq E$. In (12), $[\cdot]$ is an interpretation function which ascribes a denotation to the expression '·'. In (12a,b), $|n|$ is the cardinality of the set $n$. $N$ in (12a) is a number specified by a discourse context $C$. $N \geq 2$, if $N$ is plural. $N=1$, if $N$ is singular. Because $[[die \ N_{pl} V^1]]$ and $[[alle \ N_{pl} V^1]]$ show the same subset relation, it is possible to unify the denotation of $die \ NP_{pl}$ and the denotation of $alle \ NP_{pl}$. As a result of unification, the interpretation of FQ in the GQ-style can be obtained as in (12c).

(12) a. $[[die \ N_{pl} V^1]]$ is true if $n \subseteq v^1$; $|n| = N$
    b. $[[alle \ N_{pl} V^1]]$ is true if $n \subseteq v^1$; $|n| \neq 0$
    c. $[[alle \ die \ N_{pl} V^1]]$ is true if $n \subseteq v^1$; $[v^1(a)]$ is true for each $a \in n$

The interpretation type of *keine*, *einige* and *viele* which appears in SNP differs from that of *die* and *alle*. While *die* and *alle* have a common interpretation type, i.e. $n \subseteq v^1$, the common interpretation type of *keine*, *einige* and *viele* is $|n \cap v^1|$. For example, *keine* ('no') in $keine_E \ N \ V^1$ determines that the intersection of $n$ and $v^1$ is empty, as shown in (13a). And *einige* ('some') in $einige_E \ N \ V^1$ determines that the intersection of the sets $n$ and $v^1$ is non-empty, i.e. its cardinality is context dependent, as in (13b). *Viele* ('many') in $viele_E \ N \ V^1$ determines that the intersection of $n$ and $v^1$
contains more individuals than those whose number is estimated as 'many' relative to the context-parameter $C_{viel}$.

(13) a. $[\text{keine Npl V}^1]$ is true if $|n \cap v^1| = 0$; $|n| \neq 0$
b. $[\text{einige Npl V}^1]$ is true if $|n \cap v^1| \geq 2$; $|n| \geq 2$
c. $[\text{viele Npl V}^1]$ is true if $|n \cap v^1| > C_{viel}^*|n|$; $|n| \neq 0$

Each bare (indefinite) plural noun in SNP in German, i.e. $N_{\text{indef,pl}}$, appears in the left periphery of the SNP-sentence and can be quantified by the $Q_{\text{SNP}}$-expressions, like *keine, einige* or *viele*, in the Mittelfeld. Therefore, each $N_{\text{indef,pl}}$ in SNP is combined first with $V^1$, and then quantified by the $Q_{\text{SNP}}$-expression, as shown in (14).

(14) a. $[N_{\text{pl V}^1 \text{ keine}}]$ is true if $|n \cap v^1| = 0$; $|n| \neq 0$
b. $[N_{\text{pl V}^1 \text{ einige}}]$ is true if $|n \cap v^1| \geq 2$; $|n| \geq 2$
c. $[N_{\text{pl V}^1 \text{ viele}}]$ is true if $|n \cap v^1| > C_{viel}^*|n|$; $|n| \neq 0$

The syntactic and semantic structure of bare plural nouns in SNP is defined as follows. The SNP structure indicated in (14) can be parsed incrementally; i.e. $N_{\text{indef,pl}}$ is applied first to $V^1$ and then to $Q_{\text{SNP}}$ in order to realize SNP-sentence $V^0$, where $Q_{\text{SNP}}$ is the syntactic category of Q-expressions of SNP. Therefore, $N_{\text{indef,pl}}$ in SNP can be redefined as a functor category $(V^0/Q_{\text{SNP}})/V^1$ which can predict first $V^1$, then $Q_{\text{SNP}}$. In order to construct the semantic structures of SNP-sentences incrementally, the semantic structure of the fronted indefinite plural noun, $n_{\text{indef,pl}}$, should be realized as a functor; see the semantic structure $f_{\text{SNP}}$ in (15b) where $Q$ is a quantifier variable of type $<<e,t>, <<e,t>,t>>$, and $n$ and $v^1$ are one-place predicate variables of type $<e,t>$. $Q(n)$ in (15b) represents the semantic structure of quantifier phrases (QPs) like *Kinder ... keine* ('children ... no') or *Kinder ... viele* ('children ... many') in (10b).
(15) a. \( N_{\text{indef.pl}} =_{df} (V^{0}/Q_{\text{SNP}})/V^{1} \)
   b. \( n_{\text{indef.pl}} =_{df} \lambda v^{1} \lambda Q.Q(n)(v^{1}) \quad \text{f}_{\text{SNP}} \)

5. Quantifiers of FQ and split NP

5.1 Plural nouns and quantifier-types

NPs constructed by indefinite determiners, e.g. *keine Kinder, einige Kinder* or *viele Kinder*, can occur in *es gibt*-sentence ('there-sentence'); therefore SNPs, e.g. *Kinder ... keine, Kinder ... einige* or *Kinder ... viele*, can also occur in *es gibt*-sentence. In SNPs, the existence of a certain set of individuals is thematized by the fronted bare plural nouns and this thematized set should be quantified by *keine, einige* or *viele* in the Mittelfeld. In contrast to the bare plural nouns in SNPs, the definite plural NPs quantified by *alle* in FQ-sentences cannot occur in *es gibt*-sentence. In FQs, *alle* presupposes the existence of the context-relevant set of the individuals which are specified by the definite plural NP in the left periphery. Because *alle* in *die Kinder ... alle* presupposes the existence of the set of the children which are contextually specified and denoted by *die Kindern*, the nonexistence of its members cannot be redefined by *keine* anymore, as shown in (16a). Because *alle* quantifies the set of contextually specified individuals, it is impossible to apply *alle* to bare plural nouns, because the indefinite cannot denote a set of specified individuals, as shown in (16b). The difference of syntactic behaviors of FQ and SNP is determined in this way by semantic characteristics of plural nouns and Q-expressions.

   b. *Blumen* habe ich *alle* gekauft.

5.2 Interpretation of plural nouns
For the purpose of analyzing FQs and SNPs, the question is, what sort of objects should be required as denotations for the plural nouns. According to Montague Semantics, the denotation of common nouns (CN) is a set, A, of individuals, i.e. \( A \subseteq E \). If the denotation of bare plural nouns is defined as a set of subsets of A on the analogy of CN, the semantic type of bare plural nouns would be \( \langle \langle e, t \rangle, t \rangle \), which differs from the semantic type \( \langle e, t \rangle \) of CN. As a result, singular nouns and plural nouns have different semantic types, which makes it impossible to treat singular indefinite nouns and plural indefinite nouns consistently. For this reason, the paper applies the semantics suggested by Link (1983) to interpret plural nouns. According to Link, \( a \oplus b \) is the individual sum or plural object of two atomic elements a and b in A. The connective \( \oplus \) connects a and b and constructs an individual sum \( a \oplus b \), and a, b and \( a \oplus b \) are individuals; that is, they are all of denotation type e. Link (1983) introduced an operator \( * \) which works on one-place predicate P and generates all the individual sums of members of the extension of P. \( *P \) is the group predicate based on P. If P denotes a set of atoms, \( *P \) denotes the set of the atoms and individual sums constructed by the subsets of atoms denoted P. In this paper, let \( P_{pl} \) be the proper plural predicate. The denotation of \( P_{pl} \) can be defined as the set of individual sums that exclude all the atomic parts in the extension of \( *P \). Because P and \( P_{pl} \) have the same type, i.e. \( \langle e, t \rangle \), the plural predicate and the singular predicate are treated in the same framework of quantification. According to Link, sums are partially ordered through the ordering relation which is expressed by the two-place predicate \( \Pi \), to be read as "is an individual part of," and satisfies \( a \Pi b \leftrightarrow a \oplus b = b \).

6. Split construction

Plural nouns in the Vorfeld of FQ-sentences and SNP-sentences in German are quantified by Q-expressions in the Mittelfeld. Despite this
similar word order, the semantic structure of FQ is different from that of SNP. The (in)definiteness of plural nouns in the left periphery of the sentence causes different prediction processes for determining what kind of Q-expressions should be selected in the Mittelfeld. This section shows how plural nouns in the Vorfeld can be quantified by Q-expressions in the Mittelfeld and how the meanings of these quantifier phrases are constructed in the course of the recognition of FQ and SNP. For this purpose, the combinatorial rules of CG are used, because they make it possible to accumulate semantic structures incrementally, and this accumulation of semantic structures licenses Q-expressions in the Mittelfeld to quantify fronted plural nouns. In order to reflect this accumulation process of meanings in the incremental parsing, prediction rules fashioned after the functor-argument scheme of combinatorial rules are applied, because they can license fronted nouns to predict the possible semantic structures of the Q-expressions which can appear in the Mittelfeld.

6.1 Split NPs

The speaker uses singular count nouns in order to denote one object and plural count nouns to denote two or more objects. However, the bare plural noun at the beginning of an SNP sentence cannot denote the concrete individual sum; it can only thematize the existence of a set of individuals which can be potentially denoted by this noun. Another role of this fronted indefinite Npl in SNP is to predict the existence of V¹ and QSNP-expressions like keine, viele or einige. These QSNP-expressions quantify the intersection \([\text{Npl}] \cap [V^1]\). For this reason, the type of the fronted bare plural nouns Nbare,pl in the SNP-sentence is not the type of the generalized quantifier, \(\langle\langle e,t\rangle,t\rangle\), but rather the type of CN, \(\langle e,t\rangle\). The type \(\langle e,t\rangle\) can be type lifted to \(\langle\langle\langle e,t\rangle,\langle e,t\rangle,\langle e,t\rangle,t\rangle\rangle\). This type lifting corresponds to the category lifting from N to NP/(NP\N), where NP\N is the category of QSNP-
expressions, like *keine*, *einige* and *viele*. Therefore NP\N, for short Q_{SNP},
corresponds to the type &lt;&lt;e,t&gt;,&lt;&lt;e,t&gt;,t&gt;&gt;. In this way, a bare plural noun
like *Kinder* (N_{pl}) can be combined with a Q_{SNP}-expression (NP\N) like
*keine* to make a GQ-expression *Kinder ... keine* (NP).

6.1.1 Split NPs in nominative

If the fronted bare plural noun in SNP is nominative, this N_{pl,nom} predicts
V\textsuperscript{1} and Q_{SNP}. Therefore, its categorial structure can be given in (17a), and
its semantic structure is f\textsubscript{1} in (17b), which corresponds to (17a). The
semantic structure of N_{pl,nom}, i.e. f\textsubscript{1}, can be applied to the semantic structure
of the Q_{SNP}-expression, e.g. to the semantic structure f\textsubscript{2} of *keine* in (17c).

\begin{align*}
(17) \ a. \ N_{pl,nom} &= \text{def} \ (V^0/Q_{SNP,nom})/V^1 \\
b. \ N_{pl,nom} &= \text{def} \ \lambda v^1 \lambda Q. Q(\lambda x. N_{pl}(x))(v^1) \quad \text{----} \quad f_1 \\
c. \ \lambda P_1 \lambda P_2. \neg \exists w [P_1(w) \land P_2(w)] \quad \text{----} \quad f_2
\end{align*}

In the following sentence (18), it is not until the verb *schwimmen* ('swim'),
whose category is V\textsuperscript{1}, is recognized that the case of *Kinder* can be
determined as nominative. Then the concatenated expression Kinder\textsubscript{nom}
*schwimmen* can predict a nominative Q_{SNP}-expression, i.e. Q_{SNP,nom}. From
the viewpoint of this prediction, the syntactic category of Kinder\textsubscript{nom} is
determined as (V\textsuperscript{0}/Q_{SNP,nom})/V\textsuperscript{1} and its semantic structure is f\textsubscript{3} in (19),
which reflects (17b).

\begin{align*}
(18) \ \text{Kinder}_{\text{nominative}} & \quad \text{schwimmen} \quad \text{hier} \quad \text{keinenom}. \\
\text{N}_{\text{pl,nom}} & \quad V^1 \quad \text{Adv} \quad \text{Q}_{\text{SNP,nom}} \\
(19) \ \text{Kinder}_{\text{nominative}} & \Rightarrow (V^0/Q_{\text{SNP,nom}})/V^1 : \lambda v^1 \lambda Q. Q(\lambda x. \text{Kind}_{pl}(x))(v^1) \quad \text{----} \quad f_3
\end{align*}

By using f\textsubscript{3}, the semantic structure of the sentence (18) will be constructed
incrementally as follows. First, the semantic structure of the verb phrase *schwimmen hier* is given as $f_4$ in (20). If $f_3$ is applied to $f_4$, the semantic structure $f_5$ of *Kinder schwimmen hier* is obtained, as shown in (21). Because $f_5$ predicts a $Q$-expression and at the next step the $Q$-expression *keine* is recognized, $f_5$ can be applied to the semantic structure of *keine*, i.e. to $f_2$ in (17c). The semantic structure of the SNP-sentence (18) is obtained by $f_5(f_2)$, as shown in (22).

(20) $\lambda y. \text{Hier(Schwimmen)}(y)$

(21) Kinder$_{\text{nom}}$ schwimmen hier $\Rightarrow V^0/Q_{\text{SNP,nom}} : f_3(f_4) = \lambda Q. Q(\lambda x. \text{Kind}_{p}(x))(\lambda y. \text{Hier(Schwimmen)}(y))$

(22) Kinder$_{\text{nom}}$ schwimmen hier keine $\Rightarrow V^0 : f_5(f_2) = \neg \exists w[\text{Kind}_{p}(w) \wedge \text{Hier(Schwimmen)}(w)]$

6.1.2 Split NPs in accusative

In German, bare plural accusative nouns, i.e. N$_{\text{pl,acc}}$, can also be fronted in the Vorfeld of the SNP-sentence, as shown in (23). In order to construct the semantic structure of (23) incrementally, the casus of the fronted bare plural noun, *Kinder*, must be determined.

(23) Kinder hat er keine.

<table>
<thead>
<tr>
<th>Children</th>
<th>has</th>
<th>he</th>
<th>no</th>
</tr>
</thead>
<tbody>
<tr>
<td>N$_{\text{pl,acc}}$</td>
<td>V$^2$</td>
<td>NP$_{\text{nom}}$</td>
<td>Q$_{\text{SNP,acc}}$</td>
</tr>
</tbody>
</table>

It is not until the two-place verb *hat*, V$^2$, and the nominative pronoun *er*, NP$_{\text{nom}}$, are recognized that the case of *Kinder* at the beginning of the sentence is determined as accusative. Then Kinder$_{\text{acc}}$ can predict at this point an accusative $Q_{\text{SNP}}$-expression. Because of this, Kinder$_{\text{acc}}$ gets a semantic structure $f_6$ in (24). By applying $f_6$ to the semantic structure of *hat*,...
i.e. to \( f_7 \) in (25), the semantic structure of \( \text{Kinder}_{\text{acc}} \) \( \text{hat} \) can be obtained as \( f_8 \) in (26). \( f_8 \) shows that \( Q \) quantifies \( z_2 \) which is an object of the transitive verb \( \text{hat} \) ('has'). Then the pronoun \( \text{er} \) appears. Because the meaning of \( \text{er} \) is a set of properties of an unspecified individual, \( \text{er} \) is translated according to Montague (1974) into \( f_9 \) in (27), where \( P \) is a predicate variable of type \(<e,t>\).

(24) \( \text{Kinder}_{\text{acc}} \Rightarrow ((V^0/Q_{\text{SNP,acc}})/\text{NP}_{\text{nom}})/V^2:\lambda v^2 \lambda x \lambda Q.Q(\lambda y.\text{Kind}_{pl}(y))(v^2(x)) \) \( f_6 \)

(25) \( \text{hat} \Rightarrow V^2:\lambda z_1 \lambda z_2.\text{Haben}(z_1, z_2) \) \( f_7 \)

(26) \( \text{Kinder}_{\text{acc}} \text{ hat} \Rightarrow (V^0/Q_{\text{SNP,acc}})/\text{NP}_{\text{nom}}: f_6(f_7) = \lambda x \lambda Q.Q(\lambda y.\text{Kind}_{pl}(y))(\lambda z_2.\text{Haben}(x, z_2)) \) \( f_8 \)

(27) \( \text{er} \Rightarrow \text{NP}_{\text{nom}}: \lambda P.P(x1) \) \( f_9 \)

In order to apply \( f_8 \) to \( f_9 \), the argument lifting proposed by Hindrics (1987) can be used. If the argument lifting is applied to (28a), then (28b) is obtained. In the same way, the semantic structure \( f_{10} \) is obtained from \( f_8 \), as shown in (29) where \( \mathcal{P} \) is the variable of the generalized quantifiers and the type of \( \mathcal{P} \) is \(<<e,t>,t>\). By applying \( f_{10} \) to \( f_9 \), the semantic structure of \( \text{Kinder hat er} \) is obtained; see \( f_{11} \) in (30).

(28) a. \((a, (b,t)) : \lambda y_a \lambda x_b . w_{(a, (b,t))}(y)(x) \)

b. \(((a,t), (b,t)) : \lambda z_{((a,t), (b,t))} \lambda x_b . z(\lambda y_a. w_{(a, (b,t))}(y)(x)) \)

(29) \( \lambda \mathcal{P} \lambda Q. \mathcal{P}(\lambda x. Q(\lambda y.\text{Kind}_{pl}(y)))(\lambda z_2.\text{Haben}(x, z_2)) \) \( f_{10} \)

(30) \( \text{Kinder}_{\text{acc}} \text{ hat er} \Rightarrow V^0/Q_{\text{SNP,acc}}: f_{10}(f_9) = \lambda Q.Q(\lambda y.\text{Kind}_{pl}(y))(\lambda z_2.\text{Haben}(x1, z_2)) \) \( f_{11} \)

In the SNP-sentence (23), \textit{keine} appears in the Mittelfeld; therefore, \( f_{11} \) can be applied to the semantic structure of \textit{keine}, which is given as \( f_{Q-\text{keine}} \) in (31). As a result of this application the semantic structure of (23) is
obtained; see f_{12} in (32).

(31) keine ⇒ Q: λ P_{1,pl} λ P_{2} . ¬ ∃ w[ P_{1,pl}(w) ∧ P_{2}(w) ] ---- f_{Q-keine}

(32) Kinder_{acc} hat er keine ⇒ V^0 : f_{11}(f_{Q-keine}) =

¬ ∃ w[ Kind_{pl}(w) ∧ Haben(x1, w) ] ---- f_{12}

The above-mentioned procedure reflects the incremental recognition process by which each partial semantic structure is accumulated step by step in the recognition of SNP-sentences.

The semantic characteristic of SNP can be summarized as follows. The bare plural noun in the beginning of an SNP-sentence can predict the Q_{SNP}-expression which quantifies the intersection of \([N]\) and \([V]\). In SNP, the existence of the individuals denoted by the fronted bare plural noun, N_{pl}, is presupposed, i.e. \(|[N]| \neq 0\). At the same time, however, the value of \(|[N] \cap [V]|\) is undetermined until the Q_{SNP}-expression appears in the Mittelfeld. As soon as the Q_{SNP}-expression is recognized, the value of \(|[N] \cap [V]|\) is determined by this Q_{SNP}-expression. If the Q_{SNP}-expression "keine" is recognized, the value of this cardinality is 0. For example, in (33a), the existence of flowers ('Blumen') denoted by the plural noun Blumen is presupposed. However, the Q_{SNP}-expression "keine" in (33a) makes vacant the intersection of the set of Blumen and the set of individuals which Anne watered yesterday.

(33) a Blumen hat Anne gestern keine gegossen.
   Flowers_{acc} has Anne yesterday no_{acc} watered

b *Anne hat Blumen gestern keine gegossen.

In order to thematize the nouns which appear in the preceding sentences in a discourse, the bare plural noun which appears in the succeeding SNP-sentence should occupy the Vorfeld, because the appearance of this thematic
N_{pl} in the beginning of the SNP-sentence also has a semantic effect of predicting the appearance of the indefinite Q_{SNP}-expression which quantifies $[N] \cap [V]$. If Blumen does not appear in the beginning of the SNP-sentence, as in (33b), the noun Blumen loses its thematic role; i.e. Blumen assumes a rhematic role, and loses its predictive force.

6.2 Floating Quantifiers

In an FQ-sentence, for example as in (34a), the fronted definite plural NP, die Blumen, denotes a specific individual group of flowers. Therefore, in contrast to SNP, the definite plural NP die Blumen in the beginning of the FQ-sentence does not necessarily have to predict the Q_{FQ}-expression alle in its Mittelfeld, as indicated in (34b). Because the fronted definite plural NP_{pl} determines its denotation as specified, i.e. as a specific individual group, it has a weak force to predict the Q_{FQ}-expression alle, because of the following fact. If the definite noun phrase die N_{pl} denotes a specified individual sum A in a discourse context, the quantifier phrase of FQ, i.e. die N_{pl} ... alle_{FQ}, denotes the same individuals that construct A. Therefore, the definite plural noun in FQ has a weak prediction force. In FQ, the definite plural NP_{pl} can appear even in the Mittelfeld, because of this weak prediction force, as shown in (34c). The Q_{FQ}-expression alle can appear even in the position where the adverb appears, as shown in (34d).

(34) a. Die Blumen hat er gestern alle gegossen.
   b. Die Blumen hat er gestern gegossen.
   c. Er hat die Blumen gestern alle gegossen.
   d. Die Blumen hat er alle gestern gegossen.

If it becomes necessary for the collective reading of die Blumen in (34b) to be interpreted distributively in a discourse context C, this C forces die
Blumen in the Vorfeld to predict that the $Q_{FQ}$-expression alle will appear in the Mittelfeld, because alle can give die Blumen a distributive reading, as shown in (34a). The $Q_{FQ}$-expression alle indicates that each individual which is a member of the individual sum denoted by die Blumen participates actively/passively in the event which $V^1$ denotes. In this way, the prediction procedures caused by plural nouns in the left periphery of the FQ-sentence are different from those of the SNP-sentence. In SNP, the bare plural noun in the beginning of the sentence shows a strong prediction force, i.e. it shows a semantic effect of predicting the appearance of the indefinite $Q_{SNP}$-expression, while the $Q_{FQ}$-expression alle in FQ is only weakly predicted by the definite plural NP. This difference in prediction force produces the decisive difference between the semantic structure of FQ and that of SNP, and this difference determines their word order.

6.2.1 The semantic structure of FQ in nominative

The FQ-sentence (35) indicates that the definite plural NP die Kinder in nominative is quantified by the $Q_{FQ}$-expression alle. A group of contextually fixed individuals, i.e. an individual sum, is denoted by the definite plural NP die Kinder in the Vorfeld and quantified by alle in the Mittelfeld. Strictly speaking, alle functions as distributor, indicating that each child ('Kind') in this group participates in the event of swimming ('schwimmen').

(35) Die Kinder schwimmen alle.

\[
\text{NP}_{\text{nom}} \quad V^1 \quad Q_{\text{nom}}
\]

By extending the semantics of plurals proposed by Link (1983), the semantic structure of definite plural nouns like die Kinder can be constructed as $f_{13}$ in (36). $f_{13}$ says that there exists a unique group of children which has a property $v^1$.  


(36) \(\text{die Kinder} \Rightarrow V^0/V^1:\)
\[
\lambda v^1. \exists z[z = \iota x[\text{Kind}_{pl}(x) \land \forall y[\text{*Kind}(y) \rightarrow y \Pi x]] \land v^1(z)] \quad \text{f}_{13}
\]

If \(\text{die Kinder}\) in the initial position of (35) is recognized in the specific context \(C\), then \(\text{die Kinder}\) denotes a set of properties which the unique individual group of children can have in \(C\). In \(f_{13}\), \(z\) is an argument of \(\text{Kind}_{pl}\) in \(C\), and this \(z\) can have the property \(v^1\). If \(f_{13}\) is applied to the semantic structure of \(\text{schwimmen}\), i.e. to \(\lambda y.\text{Schwimmen}(y)\), then \(v^1\) is replaced by \(\text{Schwimmen}\), as shown in (37).

(37) \(\text{die Kinder schwimmen} \Rightarrow V^0:\)
\[
\exists z[z = \iota x[\text{Kind}_{pl}(x) \land \forall y[\text{*Kind}(y) \rightarrow y \Pi x]] \land \text{Schwimmen}(z)]
\]

In order to complete the analysis of FQ in (35), the category of the floated quantifier \(\text{alle}_{\text{nom}}\) should be clarified. For this purpose, the construction process of the FQ-sentence should be observed. In (38a), \(\text{alle}_{\text{nom}}\) quantifies the nominative definite plural NP \(\text{die Kinder}_{\text{nom}}\). Let the category of the complex nominal phrase \(\text{alle die Kinder}_{\text{nom}}\) be a nominative quantifier phrase, i.e. \(\text{QP}_{\text{nom}}\). In (38a), \(\text{alle}_{\text{nom}}\), which precedes \(\text{die Kinder}_{\text{nom}}\), quantifies this \(\text{NP}_{\text{nom}}\). Thus, the category of \(\text{alle}_{\text{nom}}\) can be given as a functor category \(\text{QP}_{\text{nom}}/\text{NP}_{\text{nom}}\), as in (38b). However, the floated quantifier \(\text{alle}_{\text{FQ,nom}}\) in (38c) appears in the Mittelfeld separated from \(\text{die Kinder}\).

(38) a. \(\text{Alle}_{\text{nom}} \text{die Kinder}_{\text{nom}} \text{schwimmen.}\)
   b. \(\text{alle}_{\text{nom}} \Rightarrow \text{QP}_{\text{nom}}/\text{NP}_{\text{nom}}\)
   c. \(\text{Die Kinder}_{\text{nom}} \text{schwimmen alle}_{\text{FQ,nom}}.\)

Therefore, the category of the floated quantifier \(\text{alle}_{\text{FQ,nom}}\) should be given in a different way from that of the \(\text{Q}_{\text{SNP}}\)-expressions in SNP. The categorial
structure of $alle_{\text{FQ, nom}}$ in (38c) can be illustrated as (39), where A is the category of the concatenated expressions $E_A$ which appear between $\text{die Kinder}_{\text{nom}}$ and $alle_{\text{FQ, nom}}$. $Q_1$ is the category of the expressions consisting of $\text{die Kinder}_{\text{nom}}$ and $E_A$. $Q_2$ is the category of the expression made up of $\text{die Kinder}_{\text{nom}}$, $E_A$ and $alle_{\text{FQ, nom}}$. The figure (39) shows that the category of the floated quantifier $alle_{\text{FQ, nom}}$ is $Q_2/Q_1$. If $Q_2/Q_1$ is divided by the category A, then $(Q_2|_{\text{wrap}A})(Q_1/A)$ is obtained, where $Q_1/A$ is equal to $NP_{\text{nom}}$ and $Q_2|_{\text{wrap}A}$ is the category of the expression which wraps an expression of category A to construct the expression of category $Q_2$. In this case, $Q_2|_{\text{wrap}A}$ is the category of the quantifier phrase $\text{die Kinder ... alle}$, i.e. $QP_{\text{nom}}$. In this way, the category of $alle_{\text{FQ, nom}}$, i.e. $Q_2/Q_1$, can be turned into $QP_{\text{nom}}\backslash NP_{\text{nom}}$, which indicates that $alle_{\text{FQ, nom}}$ in the Mittelfeld quantifies $NP_{\text{nom}}$ in the Vorfeld.

(39)

\[
\begin{array}{c}
\text{Q2} \\
\text{Q1} \\
\text{Die Kinder}\_\text{nom} \ldots \ldots \text{E}_A \ldots \ldots \text{alle}\_\text{FQ, nom} \ldots \ldots \\
\text{NP}\_\text{nom} & \text{A} & Q_2/Q_1
\end{array}
\]

This category of $alle_{\text{FQ, nom}}$, i.e. $QP_{\text{nom}}\backslash NP_{\text{nom}}$, can become $(V^0|_{\text{wrap}V^1})\backslash NP_{\text{nom}}$, because $QP_{\text{nom}}$ is $V^0|_{\text{wrap}V^1}$. For example, if $\text{die Kinder ... alle}$ ($QP_{\text{nom}}$) wraps $\text{schwimmen}$ ($V^1$), the FQ-sentence $\text{die Kinder schwimmen alle}$ ($V^0$) is obtained. It should be noted that if the rule of associativity, i.e. $(X|_{\text{wrap}Y})Z = (X\backslash Z)|Y$, is applied to the category $(V^0|_{\text{wrap}V^1})\backslash NP_{\text{nom}}$, then $(V^0\backslash NP_{\text{nom}})|V^1$ is obtained, which is equal to the adverbial category $V^1\backslash V^1$, because $V^0\backslash NP_{\text{nom}}$ is $V^1$. The following figure (40) shows that $alle_{\text{FQ, nom}}$ can be combined not only with $NP_{\text{nom}}$, $\text{die Kinder}$, but also with $V^1$, $\text{schwimmen}$, and this indicates that $alle_{\text{FQ, nom}}$ can also play the role of
6.2.2 The semantic structure of $FQ$ in accusative

Even in the case of the accusative $FQ$, i.e. $alle_{FQ,acc}$, its category can be obtained in the same way as shown in 6.2.1. If the accusative $NP_{acc}$, e.g. $die\ Blumen_{acc}$ in (41a), combines with $V^2$, then $V^1$ is obtained. Therefore, $NP_{acc}$ is $V^1/V^2$. This $V^1/V^2$ is able to be combined with the category of the auxiliary verb $hat$, $V^n/V^n$, if $n$ is adjusted to 2, as indicated in (41b). In this way, the category of the quantifier phrase $Die\ Blumen\ldots\ alle_{FQ,acc} (QP_{acc})$ can be obtained, even if $die\ Blumen_{acc}$ is first combined with the auxiliary verb $hat$, as shown in (42).

(41) a. Die Blumen hat Hans alle gegossen.

The flowers has Hans all watered

b. $\begin{array}{cccccc}
NP_{acc} & hat & er & alle_{FQ,acc} & gegossen. \\
\hline
V^n/V^n & V^n/V^n & V^n/V^n & QP_{acc}/NP_{acc} & V^2
\end{array}$

\[= V^1/V^2 \quad V^2/V^2 \quad V^1/V^2\]
Floating Quantifiers and Split NPs in German Syntax/Semantics Interface

(42) \( \text{QP}_{\text{acc}} \)

\[
\begin{array}{c}
\text{Die Blumen}_{\text{acc}} \quad \text{hat} \\
\text{NP}_{\text{acc}} \quad V^n/V^n \\
= V^1/V^2 \\
\downarrow \\
V^2/V^2 \\
\hline \\
V^1/V^2
\end{array}
\]

If \( \text{QP}_{\text{acc}} \) wraps a nominative \( \text{NP}_{\text{nom}} \) and combines with a transitive verb \( V^2 \) on its right, the sentence (41a), \( V^0 \), is constructed. Therefore, the categorial structure of \( \text{QP}_{\text{acc}} \) is \( (V^0|\text{wrap} \text{NP}_{\text{nom}})/V^2 \). Because \( V^0|\text{wrap} \text{NP}_{\text{nom}} \) is the category of one-place verbs \( V^1 \), \( \text{QP}_{\text{acc}} \) is equal to \( V^1/V^2 \). Because \( \text{NP}_{\text{acc}} \) is \( V^1/V^2 \), the category of \( \text{alle}_{\text{FQ,acc}} \), i.e. \( \text{QP}_{\text{acc}}\backslash\text{NP}_{\text{acc}} \), can be \( (V^1/V^2)(V^1/V^2) \).

By applying this category of \( \text{alle}_{\text{FQ,acc}} \) to the category of \( \text{die Blumen}_{\text{acc}} \ \text{hat} \), i.e. to \( V^1/V^2 \), the category of \( \text{die Blumen}_{\text{acc}} \ \text{hat} ... \text{alle}_{\text{FQ,acc}} \) is obtained as \( V^1/V^2 \), as shown in (42). Parallel to the category of \( \text{alle}_{\text{FQ,acc}} \) as \( \text{NP}-\text{quantifier} \), i.e. \( \text{QP}_{\text{acc}}\backslash\text{NP}_{\text{acc}} \), this is equal to \( (V^1/V^2)(V^1/V^2) \) and can also be an adverbial category \( V^2/V^2 \), because \( (V^1/V^2)(V^1/V^2) \) can be modified by the rule of associativity into \( (V^1(V^1/V^2))/V^2 \), and \( V^1(V^1/V^2) \) is equal to \( V^2 \).

In the sentence (2c), repeated below, the Q-expression \( \text{alle} \) in FQ appears in the position where adverbs appear. Compared with the sentence (2a), which shows the typical FQ word order, the word order in (2c) is also possible. This word order proves that the category of \( \text{alle} \) can be changed to the adverb-like category, as indicated in this section. By contrast, the SNP sentences (3a) and (3c) show a different word order from FQ. The word order of (3c), in which the Q-expression \( \text{keine} \) occupies the place of the adverb position, is less acceptable than that of (3a), because \( \text{keine} \) cannot have an adverb-like category.
(2) a. Die Blumen hat er gestern alle gegossen.
   c. Die Blumen hat er alle gestern gegossen.
(3) a. Blumen hat er gestern keine gegossen.
   c. Blumen hat er keine gestern gegossen.

6.2.3 The semantic structure of alle as NP quantifier

Because the category of alle, i.e. QFQ,nom, is a functional category
QPFW,nom\NP_def,pl,nom, its semantic correspondent QFQ,nom also has a
functional structure λ NP_def,pl,nom QPFW,nom; see (43). The semantic structure
of die Kinder nom ... alle nom is obtained by applying λ NP_def,pl,nom QPFW,nom to
the semantic structure f13 of die Kinder nom in (36), repeated in (44). In order
to obtain the semantic structure of die Kinder nom ... alle nom, the meaning of
alle nom should be incorporated into the semantic structure of die Kinder nom.
If QFQ,nom is applied to f13, the semantic structure of die Kinder nom ... alle nom
can be obtained; see f14 in (45).

(43) alle ⇒ QFQ,nom : QFQ,nom where
QFQ,nom = df QPFW,nom \NP_def,pl,nom and QFQ,nom = df λ NP_def,pl,nom QPFW,nom
where
NP_def,pl,nom = df v1. ∃ z[z = i x[Np(x) ∧ ∃ y*[N(y) → yΠx]] ∧ v1(z)]
QPFW,nom = df v1. ∃ z[z = i x[Np(x) ∧ ∃ y*[N(y) → yΠx]] ∧ ∃ u[Dz(u) → v1(u)]]

(44) die Kinder nom ⇒ V0/V1 :
    λ v1. ∃ z[z = i x[Kindp(x) ∧ ∃ y*[Kind(y) → yΠx]] ∧ v1(z)] ---- f13
(45) die Kinder nom ... alle nom ⇒ QPFW,nom = V0|wrapV1 :
    λ v1. ∃ z[z = i x[Kindp(x) ∧ ∃ y*[Kind(y) → yΠx]] ∧ ∃ u[Dz(u) → v1(u)]] ---- f14

The variable z in the semantic structures f13 and f14 denotes an individual
sum. In (45), the individual sum z corresponds to a group of individuals
which are children. If the distributive operator 'D' that was proposed by Link (1986) is applied to an expression G which denotes an individual group, then the denotation of DG is a set of individuals derived from this group; i.e. DG is an expression of type <e,t>. In f14, the denotation of Dz is a set of individuals which are children; this set is derived from the group of children and u denotes each member of this set denoted by Dz. In this way, the semantic structure of alleFQ,nom as NP-quantifier can be determined as (43).

If f14 in (45) is applied to λ x1.Schwimmen(x1), the semantic structure of FQ-sentence Die Kinder schwimmen alle is obtained as f15 in (46), which guarantees the distributive reading.

\[
\text{(46)} \quad \text{die Kinder}_{\text{nom}} \text{ schwimmen alle}_{\text{nom}} \Rightarrow V^0 : f_{14}(\lambda x1.\text{Schwimmen}(x1)) = \exists z[z = \iota x[\text{Kind}_p(x) \land \forall y[\text{*Kind}(y) \rightarrow y \Pi x]]] \land \forall u[Dz(u) \rightarrow \text{Schwimmen}(u)] ---- f_{15}
\]

6.3 Incremental parsing of split constructions

Using the devices developed in this paper, both FQ and SNP can be incrementally parsed. For example, by applying the construction procedure of accusative split NPs described above, the semantic structure of Bücheracc lesen in the SNP-sentence (47) can be constructed as f16 in (48). This semantic structure f16 can be changed by "argument lifting" into f17 in (48). If f17 is applied to the semantic structure of die Kinder_{nom}, i.e. f13 in (44), the semantic structure of Bücher lesen die Kinder is obtained as f18 in (49). If the quantifier keine is recognized, f18 is applied to the semantic structure of keine, i.e. to f19 in (50). The semantic structure of the SNP-sentence (47) is completed as f20 in (51).

(47) Bücher lesen die Kinder keine.

(48) Bücheracc lesen ⇒ V1\|Q :

\[
\lambda x1.\lambda Q.Q(\lambda y1.\text{Buch}_p(y1))(\lambda z1.\text{Lesen}(x1, z1)) ---- f_{16}
\]
(49) Bücher lesen die Kinder ⇒ \( V^0 \mid Q : f_{17}(f_{13}) = \)
\( \lambda \ Q. \exists z = t \ x[\text{Kind}_{pl}(x) \land \forall y[\text{*Kind}(y) \rightarrow y \Pi x]] \land \)
\( Q(\lambda y1.\text{Buch}_{pl}(y1))(\lambda z1.\text{Lesen}(z1, z1)) \)

(50) keine ⇒ Q : \( \lambda P_1 \lambda P_2 . \neg \exists w[P_1(w) \land P_2(w)] \)

(51) Bücher lesen die Kinder keine ⇒ \( V^0 : f_{18}(f_{19}) = \)
\( = \exists z = t \ x[\text{Kind}_{pl}(x) \land \forall y[\text{*Kind}(y) \rightarrow y \Pi x]] \land \)
\( \neg \exists w[\text{Buch}_{pl}(w) \land \text{Lesen}(z, w)] \)

6.4 Split NPs constructed by 'viele'

As shown in the following SNP-sentences (52a,b), both keine ('no') and viele ('many') can construct split NPs of the same word order. However, the syntactic/semantic features of viele are distinct from those of keine. While keine cannot occur in adjective position, viele is accepted in adjective position, as shown in (53a,b).

(52) a. Blumen hat er gestern keine gegossen.
    
b. Blumen hat er gestern viele gegossen.
(53) a. *die keine Kinder
    
b. die vielen klugen Kinder

Although viele has an adjectival feature, it shows different characteristics from those of attributive adjectives, because viele cannot denote a property of individuals. By using (54b) and (54c), the semantic structure of attributive adjective klug ('clever'), (54a), can be embedded into the semantic structure of die klugen Kinder, as shown in (54d).

(54) a. klug ⇒ N/N : \( \lambda P \lambda x.[P(x) \land \text{Klug}(x)] \)
b. Kind ⇒ N: λ x.Kind(x)
c. die ⇒ NP/Npl:
   λ P pl λ v1. ∃ z [z = ι x[P pl(x) \land \forall y[*P(y) \rightarrow y\Pi x]] \land v1(z)]
d. die klugen Kinder ⇒ V0/V1:
   λ v1. ∃ z [z = ι x[Kind pl(x) \land Klug pl(x) \land
   \forall y[[*Kind(y) \land *Klug(y)] \rightarrow y\Pi x]] \land v1(z)]

While viele kluge Kinder is grammatical, kluge viele Kinder is not. Therefore, viele cannot have the semantic structure of attributive adjectives as klug dose. Let kluge Kinder be a bare plural noun phrase, because it has no determiner/quantifier. The semantic role of viele is to construct a quantifier phrase QP such as viele kluge Kinder, while the attributive adjective cannot construct QPs. Moreover, viele Kinder cannot give a distributive reading, but can only select a set of individual groups of Kinder. Viele Kinder presupposes the existence of the set of individual groups which are composed of children; however, the number of individuals which are contained in each member of the set of individual groups determined by viele Kinder is context-dependent. For example, the number of individuals which are contained in each member of individual groups denoted by viele Kinder in dem Klassenzimmer ('many children in the class room') differs from that of the individual groups denoted by viele Kinder in Deutschland ('many children in Germany'). Therefore, viele selects a set of individual groups and each group has a number of members that is classified as "many" in a discourse context. Because of this features, viele has the semantic structure fQ-viel-1, as shown in (55).

\[ (55) \text{viele} \Rightarrow Q_{\text{ADJ}} : \lambda P pl \lambda v1. \exists w[P pl(w) \land v1(w) \land \text{viel}(w)] \quad \text{fQ-viel-1} \]

The variable w in fQ-viel-1 denotes an individual sum which is a member of the set of individual sums denoted by P pl and v1. The argument w of viel in
f_{Q\text{-viel-1}} can denote an individual group \( w \) that contains only those individuals whose number is classified as "many" in a discourse context. In other words, \textit{viel} accepts only such a \( w \) whose \( \|Dw\| \) is classified as "many", where \( \|Dw\| \) is the cardinality of the set which is obtained by the application of the distributive-operator 'D' to \( w \). The semantic structure \( f_{Q\text{-viel-1}} \) in (55) shows that the adjective \textit{viele} functions at the same time as quantifier. This can be illustrated by analysis of the following SNP-sentence (56), where \textit{viele} quantifies the fronted bare plural noun \( Bären_{acc} \) ('bears'). By applying \( f_{Q\text{-viel-1}} \), the SNP determined by \textit{viele} can be analyzed as follows. First, as shown in (17a,b), the bare plural noun \( Bären_{acc} \) at the beginning of the SNP-sentence (56) predicts \( V^1 \) (one-place verb phrase) and a \( Q_{\text{SNP}} \)-expression. Because of this prediction it has the semantic structure \( f_{21} \) in (57). The variable \( x \) in \( f_{21} \) denotes an individual group in the set of individual groups denoted by \( Bär_{pl} \).

\[
(56) \quad Bären_{acc} \text{ gibt es viele}_{acc}.
\]

Bears there are many

\[
(57) \quad Bären_{acc} \Rightarrow (V^0/Q)/V^1 : \lambda v^1 \lambda Q.Q(\lambda x.Bär_{pl}(x))(v^1) \quad ---- \quad f_{21}
\]

\[
(58) \quad \text{gibt es } \Rightarrow V^0|\text{NP}_{acc} = V^1 : \lambda y.\text{exist}(y) \quad ---- \quad f_{22}
\]

\[
(59) \quad Bären_{acc} \text{ gibt es } \Rightarrow V^0|Q : \quad f_{21}(f_{22}) = \\
\quad \lambda Q.Q(\lambda x.Bär_{pl}(x))(\lambda y.\text{exist}(y)) \quad ---- \quad f_{23}
\]

\[
(60) \quad Bären_{acc} \text{ gibt es viele } \Rightarrow V^0 : \quad f_{23}(f_{Q\text{-viel-1}}) = \\
\quad \exists w[Bär_{pl}(w) \land \text{exist}(w) \land \text{viel}(w)]
\]

\( Bären_{acc} \) in (56) is a complement of the one-place verb phrase \textit{gibt es} ('there are'). This verb phrase should be saturated by an accusative complement. The semantic structure of \textit{gibt es} is given as \( f_{22} \) in (58), where \textit{exist}(y) means that a denotation of \( y \) exists. By applying \( f_{21} \) to \( f_{22} \), the semantic structure of \( Bären_{acc} \text{ gibt es} \) is obtained; see \( f_{23} \) in (59) where \( Q \) is predicted by the bare plural noun \( Bären_{acc} \). If the predicted \( Q_{\text{SNP}} \)-expression \textit{viele} is
recognized, its semantic structure \( f_{Q \cdot \text{viel}-1} \) functions as an argument of \( f_{23} \). The semantic structure of the SNP in (56) is completed by this application, as shown in (60).

The \( Q_{\text{SNP}} \)-expression \( \text{viel} \) exhibits diverse split constructions. For example, the SNPs in sentences (61a) and (61b)\(^7\) are different from that in (56).

(61) a. \( \text{Weiße Bären}_{\text{acc}} \text{ gibt es vielen}_{\text{acc}}. \)

White Bears there are many

b. \( \text{Bären}_{\text{acc}} \text{ gibt es vielen}_{\text{acc}} \text{ weiße}. \)

Bears there are many white

The plural noun \( \text{Bären}_{\text{acc}} \) in the Vorfeld of (61a) combines with an adjective \( \text{weiße} \) ('white'), and this complex bare plural noun \( \text{weiße Bären}_{\text{acc}} \) is quantified by the adjectival quantifier \( \text{viel} \) which appears in the Mittelfeld. In (61b), the adjectival quantifier \( \text{viel} \) in the Mittelfeld combines with the adjective \( \text{weiße} \), and this adjectival complex \( \text{viel weiße} \) quantifies the fronted bare plural noun \( \text{Bären}_{\text{acc}} \). Despite their complex split NP constructions, sentences (61a) and (61b) can be parsed incrementally if the semantic structure of \( \text{viel} \) is applied. For example, the semantic structure of the complex bare plural noun \( \text{weiße Bären}_{\text{acc}} \) in (61a) can be given as \( f_{24} \) in (62). If \( f_{24} \) is applied to \( f_{22} \) of \( \text{gibt es} \) and then to \( f_{Q \cdot \text{viel}-1} \) of \( \text{viel} \), the semantic structure of (61a) is completed; see (63).

(62) \( \text{weiße Bären}_{\text{acc}} \Rightarrow (V^0/Q)/V^1 : \)

\[ \lambda \, v^1 \lambda \, Q \cdot Q(\lambda \, x. [Bär_{pl}(x) \land \text{Weiß}(x)])(v^1) \quad \text{-----} \quad f_{24} \]

(63) \( \text{weiße Bären}_{\text{acc}} \text{ gibt es viele} \Rightarrow V^0 : (f_{24}(f_{22}))(f_{Q \cdot \text{viel}-1}) = \)

\[ \exists \, w[[Bär_{pl}(w) \land \text{Weiß}(w)] \land \text{exist}(w) \land \text{viel}(w)] \]

The semantic structure of (61b) can be obtained by applying the semantic
structure of Bären$\text{acc}$ gibt es, i.e. f$_{23}$ in (59), to the semantic structure of viele weiße. The latter can be constructed as follows. The semantic structure of the attributive adjective weiße is f$_\text{weiß}$ in (64). If the adjectival quantifier viele is combined with weiße (ADJ), then the quantifier-adjective complex viele weiße (QADJ) is constructed. In this case, the category of viele is QADJ/ADJ, as shown in (65), where ADJ is an argument of the semantic structure of viele, f$_\text{Q-viel-2}$. If f$_\text{Q-viel-2}$ is applied to f$_\text{weiß}$, the semantic structure of viele weiße is obtained, i.e. QADJ=f$_{25}$ in (66). The attributive meaning of weiße is incorporated in f$_{25}$. If the semantic structure of Bären$\text{acc}$ gibt es, i.e. f$_{23}$ in (59), is applied to the semantic structure of viele weiße, i.e. to f$_{25}$, the semantic structure f$_{26}$ of the SNP-sentence (61b) is obtained; see (67).

\begin{align}
(64) \text{weiße} & \Rightarrow \text{ADJ} = \text{df N/N} : \text{ADJ} = \text{df } \lambda \text{ x} . [ \text{P} (\text{x} ) \land \text{Weiß} (\text{x})] \quad \text{---- f}_\text{weiß} \\
(65) \text{viele} & \Rightarrow \text{QADJ/ADJ} : \lambda \text{ ADJ. QADJ} = \\
& \lambda \text{ P} ^\text{pl} \lambda \text{ v} ^\text{1}. \quad \exists \text{w}[ \text{P} ^\text{pl} (\text{w}) \land \text{v} ^\text{1} (\text{w}) \land \text{viel} (\text{w}) \land \text{ADJ} (\text{P} ^\text{pl} (\text{w}))] \quad \text{---- f}_\text{Q-viel-2} \\
(66) \text{viele weiße} & \Rightarrow \text{QADJ} : \text{QADJ} = \text{f}_\text{Q-viele-2}(\text{f}_\text{weiß}) = \\
& \lambda \text{ P} ^\text{pl} \lambda \text{ v} ^\text{1}. \quad \exists \text{w}[ \text{P} ^\text{pl} (\text{w}) \land \text{Weiß} (\text{w}) \land \text{v} ^\text{1} (\text{w}) \land \text{viel} (\text{w})] ^\text{8} \quad \text{---- f}_{25} \\
(67) \text{Bären}_\text{acc} \text{ gibt es viele weiße} & \Rightarrow \text{V} ^\text{0} : \text{f}_{23}(\text{f}_{25}) = \\
& \exists \text{w}[ \text{Bär}_\text{pl} (\text{w}) \land \text{Weiß} (\text{w}) \land \text{exist} (\text{w}) \land \text{viel} (\text{w})] \quad \text{---- f}_{26} \\
\end{align}

6.5 Split NPs in dative

In German, it is possible to construct an SNP-sentence which consists of the fronted bare plural noun in dative and the dative adjectival quantifier vielen in the Mittelfeld, as shown in (68)$^9$. The SNP in dative can also be parsed incrementally. The fronted bare plural noun in dative can predict a two-place verb V$^2$ which takes two complements in nominative and dative respectively; therefore the dative noun Flüchtlingen$\text{dat}$ ('refugees') has the semantic structure f$_{27}$, as indicated in (69)$^{10}$. 
(68) Flüchtlingen\textsubscript{dat} hatte Anne vielen\textsubscript{dat} geholfen.

Refugees\textsubscript{dat} had Anne many\textsubscript{dat} helped

(69) Flüchtlingen\textsubscript{dat} \Rightarrow (V^1/Q)/V^2:

\[ \lambda v^2 \lambda x \lambda Q.Q(\lambda y.Flüchtling\textsubscript{pl}(y))(v^2(x)) \quad \text{---- f}_{27} \]

Because the auxiliary {	extit{hatte}} ('had') combines with an arbitrarily n-place verb \( V^n \) and produces again the same n-place verb phrase \( V^n \), \textit{hatte} has an adverbial category \( V^n|V^n \). And if the past participle of \( V^n \) combines with the auxiliary \textit{hatte}, the tense changes to the past perfect, thus allowing the semantic structure of \textit{hatte} to be defined as \( f_{1} \) in (70a), where \( \bar{t} \) is used to indicate the past perfect tense which is determined by the auxiliary verb \textit{hatte}. If \( V^n|V^n \) is combined with a k-place verb \( V^k \), \( V^n|V^n \) is adjusted to \( V^k|V^k \). Because \textit{hatte} in (68) combines with the two-place verb \textit{geholfen} ('helped'), n is adjusted to 2, i.e. \( V^2|V^2 \); see (70b) and (70c). If the category of \textit{Flüchtlingen}\textsubscript{dat}, \( (V^1/Q)/V^2 \), and the category of \textit{hatte}, \( V^n|V^n \), are combined by the composition rule, the category of \textit{Flüchtlingen}\textsubscript{dat} \textit{hatte}, i.e. \( (V^1/Q)/V^2 \), can be obtained, and its semantic structure can be constructed as \( f_{28} \) in (71), where \( v^2(x) \) in \( f_{27} \) is changed by \textit{hatte} to \( \bar{t}(v^2(x))^{11} \).

(70) a. \textit{hatte} \Rightarrow V^n|V^n : \lambda y^n \lambda x_n... \lambda x_1.(\bar{t}(v^n(x_1,...,x_n))) \quad \text{---- f}l

b. \textit{geholfen} \Rightarrow V^2 : \lambda y^2 \lambda y_1.Helfen(y_1,y_2) \quad \text{---- g}1

c. \textit{hatte} ... \textit{geholfen} \Rightarrow V^2 : f_1(g_1) = \lambda x_2 \lambda x_1.(\bar{t}(Helfen(x_1,x_2)))

(71) Flüchtlingen\textsubscript{dat} \textit{hatte} \Rightarrow (V^1/Q)/V^2:

\[ \lambda v^2 \lambda x \lambda Q.Q(\lambda y.Flüchtling\textsubscript{pl}(y))(\lambda y_2.(\bar{t}(v^2(x,y_2))))^{12} \quad \text{---- f}_{28} \]

The next step proceeds as follows. The syntactic category of \textit{Flüchtlingen}\textsubscript{dat} \textit{hatte} and that of \textit{Anne} can be combined by applying the composition rule; see (72). For this purpose the category of \textit{Flüchtlingen}\textsubscript{dat} \textit{hatte}, \( (V^1/Q)/V^2 \), is turned into \( (V^1/V^2)/Q \) by the associativity rule.
In (72), g2 is the semantic structure of Flüchtlingendat hatte, and h2 is that of Anne. The category of Anne, i.e. V0|V1, can be divided by V2 to obtain the category (V0/V2)|(V1/V2), because its appearance is predicted by Flüchtlingendat hatte. The semantic structure f2 corresponds to this category. The semantic structures g2, h2 and f2 can be explicitly represented in (73a), (73b) and (73c) respectively. If the categories of Flüchtlingendat hatte and Anne are composed, the category of Flüchtlingendat hatte Anne is obtained, i.e. (V0/V2)/Q. Corresponding to this category, the semantic structure of Flüchtlingendat hatte Anne is obtained as λ Q.f2(g2(Q)), which is equal to f29 in (74).

(73) a. Flüchtlingendat hatte ⇒ (V1/V2)/Q : g2 =df

λ Q λ v2 λ x.Q(λ y.Flüchtling_pb(y))(λ y2.(t~(v2(x, y2))))

b. Anne nom ⇒ NP nom = V0|V1 : h2 =df λ P.P(a) ---- fAnne
c. If V0|V1 : h2, then (V0/V2)|(V1/V2) : f2 =df λ z1 λ z2. h2(z1(z2)), where V1/V2 : z1, V2 : z2.

(74) Flüchtlingendat hatte Anne nom ⇒ (V0/V2)/Q : λ Q1.f2(g2(Q1)) =

λ Q1 λ z2.Q1(λ y.Flüchtling_pb(y))(λ y2.(t~(z2(a, y2))))13 ---- f29

If f29 is applied to fQ-viele-1, repeated in (75a), the semantic structure of Flüchtlingendat hatte Anne nom vielen_dat can be constructed as f2(g2(Q_w)) in (75b); this is equal to f29(fQ-viel-1), which can be completed as f30 in (75c), where z2 is the variable of two-place predicates.
Floating Quantifiers and Split NPs in German Syntax/Semantics Interface

(75) a. viele \( \Rightarrow Q_{\text{ADJ}}: Q = \lambda P_{\text{pl}} \lambda v^1. \exists w[P_{\text{pl}}(w) \land v^1(w) \land \text{viel}(w)] \) ---- \( f_{Q\text{-viel}-1} \)

b. Flüchtlingendat hatte Anne nom vielen dat
\((V^0|V^2)|Q : \lambda Q . f_2(g_2(Q)) = f_{29} \) \( Q : Q_w = f_{Q\text{-viel}-1} \)
\( V^0|V^2 : f_2(g_2(Q_w)) = f_{29}(f_{Q\text{-viel}-1}) \)

c. \( f_{29}(f_{Q\text{-viel}-1}) \)
\( = \lambda z^2. \exists w[\text{Flüchtling}_{pl}(w) \land \vec{t}(z^2(a, w)) \land \text{viel}(w)]^{14} \) ---- \( f_{30} \)

The semantic structure \( f_{30} \) in (75c) predicts two-place verb \( z^2 \). If the two-place verb \( \text{geholfen} \) is recognized, \( f_{30} \) can be applied to the semantic structure of \( \text{geholfen} \), i.e. to \( g_1 \) in (70b), which is repeated as \( f_{31} \) in (76). The result of this application, which is schematized in (77a), is indicated in (77b).

(76) \( \text{geholfen} \Rightarrow V^2 : \lambda x_1 \lambda x_2 . \text{Helfen}(x_1, x_2) \) ---- \( f_{31} \)

(77) a. Flüchtlingendat hatte Anne vielen geholfen.
\( V^0|V^2 : f_{30} \) \( V^2 : f_{31} \)
\( V^0 : f_{30}(f_{31}) \)

b. Flüchtlingendat hatte Anne vielen geholfen \( \Rightarrow V^0 : f_{30}(f_{31}) = \)
\( \exists w[\text{Flüchtling}_{pl}(w) \land \vec{t}(\text{Helfen}(a, w)) \land \text{viel}(w)] \)

The procedure described above shows that the incremental accumulation of each semantic structure of the dative SNP is also possible. This accumulation process reflects the left and right dislocation phenomena of SNP, which are different from those of FQ. The research shows that the difference between FQs and SNPs is reflected explicitly in the accumulation process of each partial semantic structure.
7. Conclusion

Drawing on the characterization of left periphery phenomena, it is shown that the grammar formalism of split construction proposed in this paper can model the dynamics of language processing. The research clarifies that the semantic structure of German split NP and that of German floating quantifier differ, despite the similarity of their word order. This difference derives from the difference in the accumulation process of semantic structures determined by the (in)definite plural nouns in the left periphery and quantifier expressions in the Mittelfeld. By showing (1) that indefinite plural nouns and quantifier expressions like *keine* of SNP have a common semantic feature, i.e. the intersection relation which is determined by \([N]\) \(\cap\) \([V^1]\), and (2) that definite plural nouns and the quantifier expression *alle* have a different common semantic feature, i.e. the subset relation which is determined by \([N]\) \(\subseteq\) \([V^1]\), this paper proposes that incremental parsing which accumulates each partial meaning of the sentence from left to right in piecemeal fashion reflects in formal structure the cognitive process by which each partial interpretation is accumulated incrementally. The research demonstrates that the accumulation process of the partial meanings of SNP differs from that of FQ. The research also shows that the efficiency of the incremental parsing depends on the predictive forces of the nouns in the left periphery of FQ and SNP. The bare plural noun in the left periphery of the SNP has a strong predictive force, because it must be combined with V and Q_{SNP} in order to quantify the set determined by \([N]\) \(\cap\) \([V]\). In contrast, the fronted definite plural nouns need not always combine with the quantifier expression *alle*, because *die N_{pl} ... alle_{FQ}* denotes the same individuals as the individuals which are members of a specified individual sum denoted by the fronted definite plural noun phrase *die N_{pl}*. Therefore, the definite plural noun in FQ has a weak predictive force. The Q_{FQ}-expression *alle_{FQ}* need not be predicted until the participation of each individual in an event needs to
be informed in a discourse. The paper concludes that the difference of the accumulation process of each partial semantic structure between FQ and SNP is explicitly determined by the difference in the predictive force of the plural nouns in the left periphery of FQ and SNP. By exploring split constructions, the research clarifies that the relation between the plural, its quantification and its word order is fundamentally determined by (in) definiteness.

Notes

1 The bare noun in SNP can also be singular; for example, "Geld habe ich keins."

2 According Kniffka (1996), the Q_{FQ}-expression *alle* in FQ can occur not only in V2 sentences, but also in interrogatives and subordinate clauses. However, according to Kniffka, the split NP construction is impossible in interrogative and subordinate clauses.

*Hat er Blumen gestern keine gegossen?*

*... weil er Blumen gestern keine gegossen hat. (Kniffka 1996, pp.2)*

3 De Kuthy (2002) investigated the semantics of the split construction from the viewpoint of HPSG.


5 In Link (1983), P_{pl} is represented as *P

6 In Japanese these two types of readings can be represented by different morphological forms:

(a) Kodomotachi-wa_{nom} zenin(-ga)_{nom} oyogu.

The children_{nom} each of them swim

(b) Kodomotachi-wa_{nom} zenin-de_{ADV} oyogu.

The children_{nom} all in group swim

"Zenin(-ga)_{nom}" in (a) has a category QP_{nom},NP_{nom} which can modify the fronted NP "kodomo-tachi ('the children')" and give a distributive reading; i.e. "each member of the set of the children swims". On the other hand, "zenin-de_{ADV}" in (b) has an adverbial category V_{1}/V_{1} and gives a collective reading; i.e. "the children swim in group".

7 Similar examples are given in Kniffka (1996, p.35)

8 f_{25} is obtained by P_{pl}(w) \land [P_{pl}(w) \land \text{Weiß}(w)] = P_{pl}(w) \land \text{Weiß}(w).
10 The dative noun Flüchtlinge also predicts ditransitive verbs like geben. Therefore, the possible predictions caused by Flüchtlinge should be processed in parallel. This parallel process is ignored here.
11 The past participle geholfen ('helped') has a basic semantic structure, as shown in (70b), and at the same time, if it combines with the auxiliary hatte, the tense changes to the past perfect, as shown in (70c).
12 $f_{28}$ in (71) can be obtained by the following conversion indicated in (a), (b) and (c):

(a) Flüchtlingen$_{dat}$ $\Rightarrow (V^1/Q)/V^2 : \lambda \text{v}^2 \lambda x \lambda Q.Q(\lambda y . \text{Flüchtling}_p(y))(\text{v}^2(x))$ ---- f''
(b) hatten $\Rightarrow V^2|V^2 : \lambda \text{v}^2 \lambda y_1 \lambda y_2. (\text{r}(\text{v}^2(y_1, y_2)))$ ---- g''
(c) Flüchtlingen$_{dat}$ hatten $\Rightarrow (V^1/Q)/V^2 : \lambda \text{v}^2.f(\text{g}(\text{v}^2))$

where $\lambda \text{v}^2.f(\text{g}(\text{v}^2)) = \lambda \text{v}^2 \lambda x \lambda Q.Q(\lambda y . \text{Flüchtling}_p(y))(\lambda y_2. (\text{r}(\text{v}^2(x, y_2))))$

13 $f_{29}$ in (74) can be obtained by the following conversion indicated in (a), (b), (c) and (d):

(a) Flüchtlingen$_{dat}$ hatte $\Rightarrow (V^1/V^2)/Q : $

$\lambda Q. \lambda \text{v}^2 \lambda x . Q(\lambda y . \text{Flüchtling}_p(y))(\lambda y_2. (\text{r}(\text{v}^2(x, y_2))))$ ---- g2
(b) Anne $\Rightarrow V^0/V^1 : \lambda P.P.(a)$ ---- h2
(c) Anne $\Rightarrow (V^0|V^2)/(V^1/V^2) : \lambda z_1 \lambda z_2. h_2(z_1(z_2))$ ---- f2 (where $V^1/V^2 : z_1, V^2 : z_2$
(d) Flüchtlingen$_{dat}$ hatte Anne $\Rightarrow (V^0|V^2)/Q : \lambda Q. Q(\lambda Q.(g_2(Q1)))$

$\lambda Q_1 \lambda z_2. Q_1(\lambda y . \text{Flüchtling}_p(y))(\lambda y_2. (\text{r}(z_2(a, y_2))))$

where

a. $g_2(Q1) = \lambda \text{v}^2 \lambda x . Q_1(\lambda y . \text{Flüchtling}_p(y))(\lambda y_2. (\text{r}(\text{v}^2(x, y_2))))$

b. $f_2(g_2(Q1)) = \lambda z_1 \lambda z_2. h_2(z_1(z_2))(g_2(Q1))$

$= \lambda z_2. h_2(g(Q1)(z_2))$

$= \lambda z_2. \lambda x . Q_1(\lambda y . \text{Flüchtling}_p(y))(\lambda y_2. (\text{r}(z_2(x, y_2))))$

$= \lambda z_2.Q_1(\lambda y . \text{Flüchtling}_p(y))(\lambda y_2. (\text{r}(z_2(a, y_2))))$

14 $f_{30}$ in (75c) can be obtained by the following conversion:

$f_{29}(f_{Q\text{-viet-1}})$

$= \lambda Q_1 \lambda z_2. Q_1(\lambda y . \text{Flüchtling}_p(y))(\lambda y_2. (\text{r}(z_2(a, y_2))))(f_{Q\text{-viet-1}})$

$= \lambda z_2. \lambda P_p . \lambda v_1. \exists w[P_p(w) \land v_1^1(w) \land \text{viet}(w)][\lambda y . \text{Flüchtling}_p(y))(\lambda y_2. (\text{r}(z_2(a, y_2))))$

$= \lambda z_2. \exists w[\text{Flüchtling}_p(w) \land r(z_2(a, w)) \land \text{viet}(w)]$ ---- f_{30}

References

Floating Quantifiers and Split NPs in German Syntax/Semantics Interface

*Linguistics and Philosophy* 4, 159-209.


ドイツ語における数量詞遊離と名詞句分離
統語と意味のインターフェイス

泉尾洋行

ドイツ語の文には、文頭の定名詞句から全称数量詞が遊離した形の分離構造すなわち数量詞遊離(FQ)と、文頭の不定名詞(裸名詞)が文の中域の数量詞により量化される形の分離構造すなわち名詞句分離(SNP)が見られる。本稿は、ドイツ語のFQとSNPは文頭の名詞句を中域の数量詞が量化するという類似した語順を示すにも関わらず、両者が示す意味構造には大きな差異があることを形式意味論により明らかにした。そのために本稿は、ラムダ抽象化により実現された関数-項関係から構成される意味結合規則に基づくと後続位置に出現しうる表現のカテゴリーと意味構造を予測できることを示し、そのことにより、数量詞の遊離と分離にそれぞれ関与する文頭の定名詞と不定名詞が示す予測構造の違いが、FQとSNPの意味構造の増進的な累積過程に重大な差異を生むことを、FQとSNPの論理構造を構成手続きの中に反映させることにより明らかにした。すなわち、FQとSNPの左周辺領域に現れた名詞句を文の中域に現れる数量詞が量化するまでの過程を論理的に形式化することにより、FQとSNPの文頭の名詞句が示す予測構造の差異が発端となって進行する両者の増進的な意味累積の差異を構造的に明らかにし

た。結論として、FQとSNPにおける文頭周辺の名詞句を中域の数量詞が量化するという一見変則的に見える語順は、実は文頭周辺の名詞が決定する予測構造の中に文構成と量化に関わる統語・意味情報を集中させるものであり、量化に関した言語情報の伝達と理解のために理にかなった効率的な語順であるといえる。本稿は以上の分析を通して、ドイツ語文の左周辺領域に位置する複数形の（不）定名詞の意味特性と、その名詞を文の中域で量化する数量詞の意味特性との間にある論理的に整合した関係を明らかにし、あわせて、人が文を認識する際に遂行する文頭から文末への意味情報の増進的な蓄積プロセスを、たとえFQやSNPのような分離構造であっても、論理構造の増進的な構築プロセスの中に反映させることができ可能であることを示した。