Chapter 2
Background

This chapter lays out the basic semantic framework I will be working with. It also introduces standard treatments of focus, polarity, pluralities and questions in natural languages, and discusses some syntactic facts about Mandarin focus particles, jiu and dou in particular. It needs to be emphasized that we will only discuss the basics, and we will be brief. Refinements and relevant details will be introduced as we move on. Finally, emphasis will be put on the role of alternatives (especially varieties of alternatives) in the grammar.

2.1 Semantic Assumptions

2.1.1 The Semantic Framework

2.1.1.1 Truth-Conditions and Semantic Values

We take the truth-conditional approach to natural language semantics standardly used by generative linguists inherited from Richard Montague and David Lewis (e.g., Montague 1973; Lewis 1970). The specific implementation used in the book comes from Heim and Kratzer (1998) and its intensional extension von Fintel and Heim (2011) (cf. Chierchia and McConnell-Ginet 2000). In this framework, the meaning of a sentence (largely) amounts to its truth-condition—the condition under which the sentence is true. Characterization of truth-conditions is achieved by compositionally assigning linguistic expressions—lexical items, phrases and sentences—semantic values (or denotations as they are usually called) by the interpretation function [[...]]. In a way that matches our intuition, proper names are assigned the individuals they refer to as their values, while sentences are assigned truth values—True (1) or False (0) as their denotations. Furthermore, to capture quantification and intensionality, [[...]]
is relativized to an assignment function \( g \) (a partial function from the set of natural numbers into the set of individuals, which takes care of pronouns, traces, variables, etc.) and a possible world \( w \) (Lewis 1986). The following entries illustrate how proper names and unembedded sentences receive their semantic values. Examples are given in Mandarin with glosses.

(1) For any possible \( w \) and any assignment function \( g \):

a. \[ \text{[Lisi]}^{w,g} = \text{Lisi} \]

b. \( \text{Lisi likai.le} \) ‘Lisi leave.ASP’
\[ \text{[Lisi likai.le]}^{w,g} = 1 \text{ iff Lisi left in } w. \]

c. \( \text{ta likai.le} \) ‘He leave.ASP’
\[ \text{[ta6 lekai.le]}^{w,g} = 1 \text{ iff } g(6) \text{ left in } w \]

It is helpful to distinguish between expressions whose denotations are dependent on the evaluation parameters (the world and the assignment function under which the denotation is evaluated) and parameter-independent expressions. As illustrated in (1-a), proper names are treated as both world and assignment function independent—in other words, they pick up the same individual in any possible world, as *rigid designators* (Kripke 1980). Sentences that do not contain free pronouns are world-dependent, as in (1-b), while sentences with free pronouns are both world and assignment function dependent, as in (1-c). Finally, unembedded sentences are usually evaluated in the actual world, notated as \( w^\star \).

Besides the two types of denotations—individuals and truth-values—discussed above, we have denotations of functional types. For example, the denotation of an intransitive verb as in (2-a) is a (characteristic) function from individuals to truth-

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1Here is a well-cited quote from (Lewis 1986): If. that might help us understand what a possible world is:

The world we live in is a very inclusive thing. Every stick and every stone you have ever seen is part of it. And so are you and I. And so are the planet Earth, the solar system, the entire Milky Way, the remote galaxies we see through telescopes, and (if there are such things) all the bits of empty space between the stars and galaxies. There is nothing so far away from us as not to be part of our world. Anything at any distance at all is to be included. Likewise the world is inclusive in time. No long-gone ancient Romans, no long-gone pterodactyls, no long-gone primordial clouds of plasma are too far in the past, nor are the dead dark stars too far in the future, to be part of the same world.…. The way things are, at its most inclusive, means the way the entire world is. But things might have been different, in ever so many ways. This book of mine might have been finished on schedule. Or, had I not been such a commonsensical chap, I might be defending not only a plurality of possible worlds, but also a plurality of impossible worlds, whereof you speak truly by contradicting yourself. Or I might not have existed at all neither myself, nor any counterparts of me. Or there might never have been any people. Or the physical constants might have had somewhat different values, incompatible with the emergence of life. Or there might have been altogether different laws of nature; and instead of electrons and quarks, there might have been alien particles, without charge or mass or spin but with alien physical properties that nothing in this world shares. There are ever so many ways that a world might be: and one of these many ways is the way that this world is.
values, capturing the intuitive idea that the denotation of a predicate in a world \(w\) is the set of individuals that bear it in \(w\) (let’s not fuss over the difference between a characteristic function and the set it characterizes).

\[\text{(2) a. } \text{likai.le ‘leave.ASP’} \]
\[\llbracket \text{likai.le} \rrbracket^{w,g} = \text{the function } f \text{ from individuals to truth-values such that for all individual } x, f(x) = 1 \text{ iff } x \text{ left in } w.\]

\[\text{b. } \text{xihuan ‘like’} \]
\[\llbracket \text{xihuan} \rrbracket^{w,g} = \text{the function } f \text{ from individuals to functions from individuals to truth-values such that for all individual } x, y, f(x)(y) = 1 \text{ iff } y \text{ likes } x \text{ in } w.\]

The function in (2-b) starts to get unintelligible, which calls for some easy-to-read notation. \(\lambda\) can be used to define functions. \(\lambda \alpha : \phi. \gamma\) represents the (smallest) function which maps every \(\alpha\) such that \(\phi\) to \(\gamma\), and we call \(\alpha\) the argument, \(\phi\) the domain condition and \(\gamma\) the value description. To give an example, \(\lambda x : x \in \mathbb{N}. x + 1\) is the successor function for natural numbers.

The functions in (2) can be represented using \(\lambda\), as in (3).

\[\text{(3) SOME LEXICAL ENTRIES 1st simplification} \]
\[\text{a. } \llbracket \text{likai.le} \rrbracket^{w,g} = \lambda x \colon x \text{ is an individual. } 1 \text{ iff } x \text{ left in } w.\]
\[\text{b. } \llbracket \text{xihuan} \rrbracket^{w,g} = \lambda x \colon x \text{ is an individual. } \lambda y \colon y \text{ is an individual. } 1 \text{ iff } y \text{ likes } x \text{ in } w.\]

Following Heim and Kratzer (1998: 37), we further simplify the use of \(\lambda\) with the following convention. The result is illustrated in (5), where both entries are written according to (4-b).

\[\text{(4) Read “[}\lambda \alpha : \phi. \gamma\text{]” as either (a) or (b), whichever makes sense.} \]
\[\text{a. “the function which maps every } \alpha \text{ such that } \phi \text{ to } \gamma”\]
\[\text{b. “the function which maps every } \alpha \text{ such that } \phi \text{ to } 1 \text{ iff } \gamma”\]

\[\text{(5) SOME LEXICAL ENTRIES 2nd simplification} \]
\[\text{a. } \llbracket \text{likai.le} \rrbracket^{w,g} = \lambda x \colon x \text{ is an individual. } x \text{ left in } w.\]
\[\text{b. } \llbracket \text{xihuan} \rrbracket^{w,g} = \lambda x \colon x \text{ is an individual. } \lambda y \colon y \text{ is an individual. } y \text{ likes } x \text{ in } w.\]

The introduction of denotations of various functional types greatly increases our inventory of denotations. It is thus convenient to have a labeling system that groups denotations into different types. Following Montague’s type theory (e.g., Montague 1973), we employ \(e\) for the type of individuals, \(t\) for the type of truth-values. Next there are functional types built from the two basic types such as \(\langle e, t \rangle\) (functions from individuals to truth values), \(\langle e, \langle e, t \rangle \rangle\) (functions from individuals to functions from individuals to truth values), and in general \(\langle \sigma, \tau \rangle\) (functions whose arguments are of type \(\sigma\) and whose values are of type \(\tau\)). Finally, since we also have possible worlds (the set of all possible worlds being \(W\)), we have functions from possible worlds to
other kinds of denotations, represented by \( \langle s, \sigma \rangle \). (6) is a recursive definition of our semantic types.\(^2\)

(6) **SEMANTIC TYPES**

a. \( e \) and \( t \) are semantic types.

b. If \( \sigma \) and \( \tau \) are semantic types, then \( \langle \sigma, \tau \rangle \) is a semantic type.

c. If \( \sigma \) is a semantic type, then \( \langle s, \sigma \rangle \) is a semantic type.

d. Nothing else is a semantic type.

(6) types all possible denotations (of natural language expressions) into different domains.

(7) **SEMANTIC DENOTATION DOMAINS** [Heim and Kratzer 1998: 303]
Let \( W \) be the set of all possible worlds, and \( D \) the set of all possible individuals.

a. \( D_e = D \), the set of all possible individuals

b. \( D_t = \{0, 1\} \), the set of truth-values

c. If \( \sigma \) and \( \tau \) are semantic types, then \( D_{\langle \sigma, \tau \rangle} \) is the set of all functions from \( D_\sigma \) to \( D_\tau \).

d. If \( \sigma \) is a type, then \( D_{\langle s, \sigma \rangle} \) is the set of all functions from \( W \) to \( D_\sigma \).

Typing our semantic denotations simplifies further our lexical entries. Adopting the usual convention that \( x, y, z \) are of type \( e \), \( P, P', Q, Q' \) of type \( \langle e, t \rangle \), and \( p, p', q, q' \) of type \( \langle s, t \rangle \), the entries in (5) are simplified as follows.

(8) **SOME LEXICAL ENTRIES**

3rd simplification

a. \( \llbracket \text{likai.le} \rrbracket^w_g = \lambda x. \text{x left in } w \).

b. \( \llbracket \text{xihuan} \rrbracket^w_g = \lambda x \lambda y. \text{y likes x in } w \)

I would like to use a final simplification. Instead of using English to describe truth-conditions, sometimes I will use a formal language similar to Ty2 (a type language with two sorts of individual types \( e \) and \( s \); Gallin 1975) as my representation language. In (9), \( \text{left}_w(x) \) is read as “\( x \) left in \( w \)”\(^3\).

(9) **SOME LEXICAL ENTRIES**

final simplification

a. \( \llbracket \text{likai.le} \rrbracket^w_g = \lambda x. \text{left}_w(x) \)

b. \( \llbracket \text{xihuan} \rrbracket^w_g = \lambda x \lambda y. \text{likes}_w(y, x) \)

Typing also makes it easier to write denotations for quantificational determiners. \( \text{Every} \) takes two sets and returns 1 iff the first set is a subset of the second set, as

\(^2\)Notice that there is no type \( s \). This follows Montague’s original set-up.

\(^3\)This is an abuse of notation. The interpretation function \( [\ ] \) returns entities/functions/truth-values, not logical expressions. Technically I shall write \( [\llbracket \text{likai.le} \rrbracket^w_g]^w_g = [\lambda x. \text{left}_w(x)]^\mathcal{L} \), assuming \( ||.||_\mathcal{L} \) is the interpretation function for the logic. I will however stick to the notation in (9), hoping that no confusion will arise. In general, I will allow myself the freedom to choose either logical representation (9) or plain English enriched with some logical symbols (8) to write denotations.
in (10-a); *a/some* takes two sets and returns 1 iff the intersection of the two sets is non-empty, as in (10-b).

(10) LEXICAL ENTRIES: DETERMINERS

a. \[[\text{every}]^{w,g} = \lambda P \lambda Q \forall x[P(x) \rightarrow Q(x)]\]

b. \[[a/some]^{w,g} = \lambda P \lambda Q \exists x[P(x) \land Q(x)]\]

### 2.1.1.2 Compositionality and LFs

The semantic framework we are adopting is also compositional, in the sense that the semantic values of syntactically complex expressions are systematically derived from the denotations of their constituents, via a limited set of compositional rules that respect the syntax of the complex expressions. The most frequently used rule is functional application (FA), which simply applies a function to its argument(s) (Heim and Kratzer 1998: 44). An illustration of FA is in (12).

(11) FUNCTIONAL APPLICATION

If \(\alpha\) is a branching node and \(\{\beta, \gamma\}\) the set of its daughters, then, for any world \(w\) and assignment \(g\): if \(\llbracket \beta \rrbracket^{w,g} \in D_{(\sigma,\tau)}\) and \(\llbracket \gamma \rrbracket^{w,g} \in D_\sigma\), then \(\llbracket \alpha \rrbracket^{w,g} = \llbracket \beta \rrbracket^{w,g}(\llbracket \gamma \rrbracket^{w,g})\).

(12)

FA: \(\left\langle \text{left}_w(\text{lis}) \right\rangle\)

\[\text{Lisi: } e \text{ likai.le: } \langle e, t \rangle\]

\[\text{li} \text{s}i \lambda x. \text{left}_w(x)\]

FA alone is not enough. For example, it cannot handle quantifiers in object positions. In (13), the object quantifier is of type \(\langle \langle e, t \rangle, \langle e, t \rangle, t \rangle\) while the intransitive verb is of type \(\langle e, \langle e, t \rangle \rangle\), FA cannot apply due to a type mismatch.

(13)

\[\text{Lisi: } e \text{ likes: } \langle e, \langle e, t \rangle \rangle \text{ } \lambda x \lambda y. \text{like}_w(y, x) \]

\[\langle \langle e, t \rangle, t \rangle \text{ } \lambda Q \forall x[\text{linguist}_w(x) \rightarrow Q(x)]\]

\[\text{every: } \langle \langle e, t \rangle, \langle e, t \rangle, t \rangle \text{ } \text{linguist: } \langle e, t \rangle \]

\[\lambda P \lambda Q \forall x[P(x) \rightarrow Q(x)] \lambda x. \text{linguist}_w(x)\]

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4I use English as examples since it is controversial whether Mandarin Chinese has real universal quantifiers. This issue will be picked up when I discuss *dou* in Sect. 3.4.2.
The standard treatment of (13) in a LOGICALFORM(LF)-based framework such as Heim and Kratzer (1998) and von Fintel and Heim (2011) is to covertly move the object quantifier across the subject—while leaving a trace $t_i$—at LF, which also creates a binder index coindexed with the trace $\lambda i$ immediately below the landing site, and to have a corresponding rule PREDICATE ABSTRACTION to interpret the resulting tree. An illustration is in (15).

\[(14)\] PREDICATE ABSTRACTION
If $\alpha$ is a branching node and $\{\lambda i, \beta\}$ the set of its daughters, then, for any world $w$ and assignment $g$: $[\alpha]^{w,g} = \lambda x.[s]^{w,g[x/i]}$, where $g[x/i]$ is a modified assignment function different from $g$ at most in that $g[x/i](i) = x$.

\[(15)\]
\[
\forall x [\text{linguist}_w(x) \rightarrow \text{like}_w(lisi, x)]
\]
\[
\langle (e, t), t \rangle
\]
\[
\lambda Q \forall x [\text{linguist}_w(x) \rightarrow Q(x)] \quad \lambda x.\text{like}_w(lisi, x)
\]
\[
\lambda 1 \quad t
\]
\[
\text{like}_w(lisi, g(1))
\]
\[
\text{Lisi}: e \quad \langle (e, t) \rangle
\]
\[
\lambda y.\text{like}_w(y, g(1))
\]
\[
\text{likes}: \langle (e, (e, t)) \rangle \quad t_1: e
\]
\[
\lambda x \lambda y.\text{like}_w(y, x) \quad g(1)
\]

In general, we take LFs—syntactic tree representations enriched with covert movement, binding indices and covert operators—to be the input of semantic interpretation.

2.1.1.3 Propositions and Entailment

The denotations discussed above are extensional; in other words, they are all semantic objects relative to a particular given world. The semantic framework we adopt also provides us with a second type of semantic values—the intension of an expression. For any expression $\alpha$, $[\alpha]^{w,g}$ is the extension of $\alpha$ in $w$, while $\lambda w.[\alpha]^{w,g}$ is its intension—the function that assigns to any world $w$ the extension of $\alpha$ in that world. Following Dowty et al. (1981: 147), we use the abbreviation in (16) to represent intensions.
2.1 Semantic Assumptions

(16) \([\alpha]_g^w := \lambda w. [\alpha]_g^w \]

One kind of intension of particular interest to us is the intension of a sentence, which in our framework employing possible worlds is a (characteristic) function that can be applied to any world and returns the truth-value of the sentence in that world (or equivalently, the set of possible worlds where the sentence is true). Sentence intensions can be taken as propositions—the meaning of declarative sentences.

Sentences and their corresponding propositions have relations between them, the most important one being entailment. Intuitively, a sentence \( \phi \) entails a sentence \( \psi \) iff: the information that \( \psi \) conveys is contained in the information that \( \phi \) conveys; or equivalently, whenever \( \phi \) is true, \( \psi \) is true too.

Treating propositions as sets of possible worlds provides an appealing formal construal of entailment. Entailment corresponds to subset relation between propositions/sets of possible worlds.

(17) **Entailment**
A sentence \( \phi \) entails a sentence \( \psi \) iff \( [\phi]_g^w \subseteq [\psi]_g^w \)

### 2.1.1.4 Intensional Contexts

Having propositions around, we can handle modal expressions, such as English *may*, *must* and Mandarin *keneng* ‘may’, *yiding* ‘must’. Syntactically, I will assume that a modal combines with a sentence (its prejacent) to form another sentence. Semantically, modals take propositions as their argument and return truth-values. In other words, they are (generalized) quantifiers over possible worlds: possibility modals such as *may* and *keneng* are existentials while necessity modals *must* and *yiding* are universals. Below in (18), \( R \) is the accessibility relation and it encodes the domain of quantification for the modal.

(18) **Modal Expressions**

a. \([\text{may/keneng}]_g^w = \lambda p \exists w'(R(w', w) \land p(w'))\]
b. \([\text{must/yiding}]_g^w = \lambda p \forall w'[R(w', w) \rightarrow p(w')]\]

We cannot interpret sentences containing modals yet. A sentence like *John may leave* cannot be interpreted by applying functional application to \([\text{may}]_g^w \) and \([\text{John leave}]_g^w \)—the former is of type \( \langle\langle s, t\rangle, t\rangle \) while the latter \( t \). A new rule—Intensional functional application—is needed.

(19) **Intensional Functional Application**

If \( \alpha \) is a branching node and \( \{\beta, \gamma\} \) the set of its daughters, then, for any world \( w \) and assignment \( g \): if \( [\beta]_g^w \in D_\sigma \) and \( [\gamma]_g^w \in D_{\langle\langle s, \sigma\rangle, t\rangle} \), then \( [\alpha]_g^w = [\gamma]_g^w ([\beta]_g^w) \).

Intentional functional application allows us to combine \([\text{may}]_g^w \) with the intension of its prejacent \([\text{John leaves}]_g^w \), an illustration of which is given in (20).
Before we end this section, I would like to use some notational convenience. Following Heim and Kratzer (1998: 304), when the choice of assignment does not matter (for example, when a sentence does not contain a free pronoun), we will drop reference to the assignement function:

\[
\text{Dropping the assignment function}
\]

Finally, I will also drop the reference to \( w \) (and the subscript \( \varepsilon \)) when convenient. The context will disambiguate, I hope, whether I am talking about intensions, extensions (relativized at \( w^* \)), or something else.

This concludes our brief introduction of the basic semantic framework to be adopted in the book. Next we are going to discuss particular natural language phenomena that require various addition/modification to the current system.

### 2.1.2 Focus Association and Alternatives

Focus particles such as English *only*, *even* and Mandarin *jiu*, *dou* “contribute to the meaning of a sentence in ways that depend on the position of the focal accent in the sentence” (Krifka 2006: 105). This is the phenomenon of *focus association* (Rooth 1985). Consider English *only*.

\[(22)\] **FOCUS ASSOCIATION: only**

a. John [VP₁ only [VP₂ introduced Bill to Sueₖ]]

b. John [VP₁ only [VP₂ introduced Billₖ to Sue]].

The only difference between (22-a) and (22-b) is their prosody but the two have different meanings. In (22-a), Sue bears prosodic prominence, and the sentence means that John introduced Bill to Sue but didn’t introduce Bill to any other people, while in (22-b), Bill bears prosodic prominence and the sentence means that John introduced Bill to Sue but didn’t introduce any other people to Sue. The two are different in truth-conditions: in a context where John introduced Bill and Mary to Sue but did no other introduction, (22-a) is true while (22-b) false.

Mandarin *jiu/zhi ‘only’, dou ‘even’* exhibit focus association as well. Here is an illustration using *jiu/zhi ‘only’*. The above description of (22) also applies here.
(23) **Focus Association: jiu/zhi**

a. Lisi \[VP_1 \text{jiu/zhi} \text{ [VP}_2 \text{jieshao.le Bier gei Su}_F] \].
Lisi \text{Jiu/only introduce.ASP Bill to Sue}
‘John only introduced Bill to Sue.’

b. Lisi \[VP'_1 \text{jiu/zhi} \text{ [VP}_2 \text{jieshao.le Bier}_F \text{ gei Su}_F] \].
Lisi \text{Jiu/only introduce.ASP Bill to Sue}
‘John only introduced BILL to Sue.’

The semantic framework sketched in the previous section cannot handle focus association. In (22) (similarly in (23)), the two outer VPs (VP₁ and VP₁’) need to have different meanings since the two sentences of which they are daughters differ in truth-conditions. Furthermore, both outer VPs have only and the inner VP (VP₂ and VP₂’) respectively as their constituents. Since we want to keep the meaning of only constant in the two cases, VP₂ and VP₂’ need to have different meanings, which however is impossible in the current framework we are adopting: VP₂ and VP₂’ have the same intention, that is, they denote the same \( (s, (e, t)) \)-function that returns the set of people that introduced Bill to Sue in \( w \) when applied to \( w \).

We need to enrich the notion of meaning. The standard way to go following Rooth (Rooth 1985) is to use alternatives. Roughly, focus triggers alternatives, and alternatives play a role in the meaning conveyed by natural language expressions. Thus two expressions, though they might agree on their truth-conditions, still differ in meanings if they have different alternatives. Here is a quote from Krifka (2007: 18) that summarizes this idea: “Focus indicates the presence of alternatives that are relevant for the interpretation of linguistic expressions.”

Before we implement this basic idea, I would like to propose a simplification regarding focus particles only, even, jiu and dou. For the purposes of this book, I will treat these focus particles as sentential/propositional operators. In other words, at least one of their argument is a proposition, namely, the proposition denoted by the only-less sentence called the prejacent (cf. the prejacent of a modal). An advantage of doing so is that we can keep a unified semantics for these particles while abstracting away the complexity of using lexical entry schema (Rooth 1985; Coppock and Beaver 2014, also see discussion in Sect. 4.3.4). This allows us to concentrate more on alternatives than on compositionality. The move is also justified by the facts we are interested in: Mandarin focus particles are always adverbs (see below for more discussion of this point); they adjoins to VP, TP but never to DP, PP. Since both TP and VP can be taken as propositional (that is, they denote propositions at some syntactic level, with the VP-internal subject hypothesis), it makes sense to say that Mandarin focus particles are always propositional operators. We thus propose the following LFs as the input to semantic interpretation. These LFs can be obtained by covertly moving only to have scope over its prejacent, similar to even-movement (Karttunen and Peters 1979; Lahiri 1998; Črnič 2014).
2 Background

(24) LF of (22- A)

only \( \pi \)  
\[ \text{John introduced Bill to Sue}_F \]

(25) LF of (22- B)

only \( \pi' \)  
\[ \text{John introduced Bill}_F \text{ to Sue} \]

Now Rooth’s idea can be implemented as follows. First, focused constituents are F-marked by an \( F \) feature in the narrow syntax (the part of syntax before spell-out, cf. Jackendoff 1972). \( F \) is interpreted both at PF (Phonological Form) and at LF (we are only interested in the LF part; for the relationship between \( F \) and prosody in English, Selkirk 1996 and Schwarzschild 1999 are two classical references). At LF, the contribution of \( F \) is formalized by assigning linguistic expressions (besides their ordinary semantic values\(^5\)) a second semantic value—the alternative semantic value by \([\alpha]_{Alt}\). Specifically, the alternative semantic value of a non-focused terminal is the singleton set consisting of its ordinary semantic value, while the alternative value of a focused node is the set of semantic values that share with its ordinary value the same type. Next, focus values of non-terminals can be computed compositionally, via pointwise functional application. Finally, note that ordinary semantic values and their composition are not affected by \( F \).

(26) Roothian Alternatives Semantics

a. Focus values for non-F-marked terminals: \([\alpha]_{Alt} = \{[\alpha]\}\)

b. Focus values for F-marked terminals:
\([\alpha_F]_{Alt} = D_\sigma\), where \( \sigma \) is the type of \([\alpha]\).

c. Pointwise functional application:
\([\alpha \beta]_{Alt} = \{f(x)|f \in [\alpha]_{Alt} \& x \in [\beta]_{Alt}\}\)

Interpretation of focus particles such as only make reference to the alternative semantic value of its prejacent. Since \( F \) affects alternative semantic value, placement of \( F \) affects the interpretation of an only-sentence.

The alternative semantic values of the prejacent in (22-a) and (22-b) are sets of propositions (type \( \langle st, t \rangle \)), as in (27) and (28).\(^6\) These sets can be compositionally derived from the rules in (26).\(^7\)

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\(^5\)Ordinary values can be extensions or intensions.

\(^6\)I use boxes to single out the prejacent proposition.

\(^7\)Technically, it is not easy to compositionally get sets of propositions in the framework we adopt from Heim and Kratzer (1998). In this framework, most semantic composition is done extensionally, and (possible world) intensions are defined as \( \lambda \)-abstraction over the world parameter. However, as is discussed in (Shan 2004; Novel and Romero 2010; Charlow 2014; Ciardelli and Roelofsen 2014).
2.1 Semantic Assumptions

(27) \[ \llbracket \pi_{(22-a)} \rrbracket_{Alt} = \begin{cases} \lambda w. \text{John introduced Bill to Sue in } w, \\ \lambda w. \text{John introduced Bill to Ann in } w, \\ \lambda w. \text{John introduced Bill to Sam in } w, \\ \cdots \end{cases} \]

(28) \[ \llbracket \pi_{(22-b)} \rrbracket_{Alt} = \begin{cases} \lambda w. \text{John introduced Bill to Sue in } w, \\ \lambda w. \text{John introduced Ann to Sue in } w, \\ \lambda w. \text{John introduced Sam to Sue in } w, \\ \cdots \end{cases} \]

Only basically says that the prejacent \( \pi \) is true in the evaluation world and propositions within \( \llbracket \pi \rrbracket_{Alt} \) that are not entailed by the prejacent proposition are all false in the evaluation world.\(^8\)

(29) \[ \llbracket \text{only } \pi \rrbracket^w = 1 \iff \llbracket \pi \rrbracket(w) \land \forall q \in \llbracket \pi \rrbracket_{Alt} [q(w) \rightarrow \llbracket \pi \rrbracket \subseteq q] \quad [\text{Schwarzschild 1994}] \]

Applied to (27), (29) negates propositions such as that John introduced Bill too Ann and that John introduced Bill to Sam (since they are not entailed by the prejacent). We get the intuitively correct truth-condition: (22-a) is true iff John introduced Bill to Sue but not to other people. Similarly, (22-b) is true iff John introduced Bill but not other people (Ann and Sam) to Sue. Focus association is accounted for.

Alternatives come in different varieties. Varieties of alternatives help us understand a set of phenomena that seems to bear no connection to focus: that is, the polarity system, to which we now turn.

2.1.3 Polarity

I follow Chierchia’s (2013) alternatives-\&-exhaustification approach to the polarity system (built on insights from Kadmon and Landman 1993; Krifka 1995; Lahiri 1998; Kratzer and Shimoyama 2002; Chierchia 2006; Fox 2007a; Chierchia et al. 2012), where implicatures and polarity items constitute a unified phenomenon and receive the same explanation. The polarity system is relevant to the discussion because (i), it illustrates how alternatives, especially varieties of alternatives, can provide a principled explanation to a seemingly highly heterogeneous system consisting of

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(Footnote 7 continued)

2015), \( \lambda \)-abstraction is problematic in alternative semantics. There are various ways to resolve this conflict. The easiest one is to modify the types of predicates. Instead of being \( \langle e, t \rangle \), a verb like leave has a denotation of type \( \langle e, st \rangle \)—a function from individual to propositions. Now we only need pointwise functional application to combine \( \llbracket \text{John } F \rrbracket_{Alt} \) with \( \llbracket \text{leave} \rrbracket_{Alt} \) into a set of propositions. I will however not dwell too much on this compositional issue in the book, since the use of propositional alternative set as in (27)-(28) is fairly uncontroversial and it is intuitively clear what the alternatives are.

8This entry will be discussed in detail Chap. 3. I am also ignoring the presuppositionality of only’s prejacent proposition.
implicatures, negative polarity items and free choice items; (ii), Mandarin wh-items are a kind of polarity items (Cheng 1997; Lin 1996) and Chaps. 5–7 of this book concern a puzzling use of wh-items in Mandarin Chinese.

2.1.3.1 Implicatures

There are fruit, cake and ice cream on the table. My son (suppose I have one) asks me what to have for desert, and I say:

(30) You can have fruit or cake.

My son is smart, and he quickly draws a variety of inferences.

(31) Implicatures of (30)

a. $\sim$ He cannot have both fruit and cake. Scalar
b. $\sim$ He can have fruit and he can have cake. Free choice
c. $\sim$ He cannot have ice cream. Exhaustive

These inferences are all plausible but they cannot be hardwired into the semantics of (30), for all of them are optional. I can explicitly cancel any one of them using the corresponding continuation in (32).

(32) Implicatures cancellation

a. And you can have both. Not scalar
b. But I’m not going to tell you which. Not free choice
c. And you can have ice cream! Not exhaustive

We call the defeasible inferences in (30) implicatures, following Grice (1975). Specifically, (31-a) is a scalar implicature (Horn 1972), (31-b) a free choice implicature (Kamp 1973), and (31-c) an exhaustive implicature (Schulz and Van Rooij 2006).

Implicatures can be seen as derived from alternatives, and varieties of implicatures from varieties of alternatives. Specifically, the implicatures in (31) arguably involve the following alternatives in (33).

(33) Varieties of Alternatives: Scalar Implicatures

a. $\mathcal{A}l_{\text{SCALAR}} = \{ \text{you can have fruit and cake} \}$
b. $\mathcal{A}l_{\text{FREE,CHOICE}} = \{ \text{you can have fruit but not cake, you can have cake but not fruit} \}$
c. $\mathcal{A}l_{\text{EXHAUSTIVE}} = \{ \text{you can have ice cream} \}$

Once alternatives are introduced into the semantic computation, they have to be utilized (alternatives being idle is not a good thing). The process of using up the alternatives is called exhaustification in Chierchia’s (2013) framework, and it is done by covert counterparts of only and even exhaustifying the alternatives and factoring their contribution into the overall meaning.
The implicatures in (31) are obtained by $\mathcal{E}xh_o$, the covert counterpart of *only*, as in (29).

\[(34) \quad [\mathcal{E}xh_o, \mathcal{A}lt \pi]^w = 1 \quad \text{iff} \quad [\pi](w) \land \forall q \in \mathcal{A}lt [q(w) \rightarrow [\pi] \subseteq q] \quad \text{[Chierchia 2013: 34]}\]

Similar to *only*, $\mathcal{E}xh_o$ asserts its prejacent and negates all alternative propositions that are not entailed by the prejacent. Applying $\mathcal{E}xh_o$ to the alternatives in (33), we get meanings that come close to the implicatures in (31).

(35) **Implicatures as Exhaustification**
   
   a. Exhaustifying $\mathcal{A}lt_{SCALAR}$: You cannot have both fruit and cake.
   
   b. Exhaustifying $\mathcal{A}lt_{FREE,CHOICE}$: You can have cake $\iff$ you can have fruit
   
   c. Exhaustifying $\mathcal{A}lt_{EXHAUSTIVE}$: You cannot have ice cream.

Above, (35-a) and (35-c) directly correspond to the implicatures we intuitively feel, as in (31-a) and (31-c). Combining (35-b)\(^9\) with the prejacent—$\Diamond(\text{you have fruit or cake})$\(^10\)—, we also get (31-b). Implicatures are accounted for.

Finally, recall from (32) that implicatures can be cancelled. This could be explained by resorting to optionally activating alternatives of a particular kind (Chierchia 2006, 2013). Suppose I say “you can have fruit or cake, and you can have ice cream”. The first clause is still able to give rise to the scalar and the free choice implicatures, but exhaustive implicatures such as (31-c) cannot be generated (or there will be a contradiction). This is accounted for by activating the alternatives in (33-a) and (33-b) but not in (33-c).

Before we leave implicatures, I would like to mention two things. First, implicatures (and varieties of implicatures) also appear in Mandarin Chinese. The following sentence (uttered in the same context as its English counterpart (30)) has the implicatures in (36), which can be cancelled by the continuations in (37). The explanation is exactly as before.

(36) *Ni keyi chi shuiguo huozhe dangao*  
You can eat fruit or cake  
‘You can eat fruit or cake’.

\(^9\)It might not be obvious why applying $\mathcal{E}xh_o$ to (33-b) amounts to $\text{CAKE} \leftrightarrow \text{FRUIT}$ (let $\text{CAKE/FRUIT}$ be ‘you can have cake/fruit’). Here are some details: the two alternatives in (33-b) are not entailed by the prejacent so they are negated, and we have $\neg(\text{CAKE} \land \neg \text{FRUIT})$ and $\neg(\text{FRUIT} \land \neg \text{CAKE})$; applying De Morgan’s laws we get $\text{FRUIT} \rightarrow \text{CAKE}$ and $\text{CAKE} \rightarrow \text{FRUIT}$; conjoining them we get (35-b).

\(^10\) $\Diamond$ is the possibility modal *can*; I use symbols instead of plain English to avoid possible confusion: the prejacent in English *you can have fruit or cake* already leads us to expect the free choice implicature.
24  Background

- a. ～Ni bu keyi liangge dou chi ‘You cannot have both’
- b. ～Ni keyi chi shuiguo ‘You can have fruit’
  ～Ni keyi chi dangao ‘You can have cake’
- c. ～Ni bu keyi chi bingqilin ‘You cannot have ice cream’

(37)  **Implicatures Cancellation**

- a. ni ye keyi liang.ge dou chi
  you also can two.cl DOU eat
  ‘and you can also have both.’
  **NOT SCALAR**
- b. dan wo bu xiang gaosu ni juti nage
  but I NEG want tell you specific which
  ‘but I don’t want to tell you which.’
  **NOT FREE CHOICE**
- c. ni ye keyi chi bingqilin
  you also can eat ice.cream
  ‘and you can also have ice cream.’
  **NOT EXHAUSTIVE**

Second, the use of alternatives and varieties of alternatives is actually theory-neutral. What we just showed is the *Grammatical* view of implicatures, according to which implicatures (at least the ones considered here) are derived from semantic computation. There is a conceptually different view—the Gricean view, which takes implicatures to be an entirely pragmatic phenomenon, arising from Gricean reasoning. Alternatives also play an important role in a Gricean theory. See for example Geurts (2010) for a recent Gricean account of various implicatures using alternative *belief states*.

### 2.1.3.2 Polarity Items

Across languages, there are expressions that are restricted to “negative” and/or “modal” environments. They are called polarity items. Typical examples include English *any, ever*, German *irgendein* and Mandarin *wh*-items (Cheng 1997; Lin 1996; Liao 2011; Chierchia and Liao 2014).

Alternatives and varieties of alternatives can also be used to explain behaviors of polarity items and variation between different polarity items. This is the *alternatives-&-exhaustificaiton* approach to polarity items (Chierchia 2013).

In Chierchia’s system, polarity items are analyzed in the same way as implicatures. They trigger alternatives (an idea going back to Fauconnier 1975) and thus need exhaustification. Different from implicatures, the alternatives they trigger are lexically specified and obligatory. Exhaustifying these alternatives in certain contexts gives rise to contradiction, and thus the polarity item is ungrammatical in these contexts.
I will illustrate Chierchia’s framework using English *ever* and German *irgendein*. Ever is a typical negative polarity item (NPI). It appears only in “negative” environments such as the ones shown in (38) (the list is not exhaustive).

(38) **ENGLISH EVER**

a. Negation
   (i) I do not ever vote republican.
   (ii) *I ever vote republican.

b. Negative Quantifier
   (i) No one has ever failed this class.
   (ii) *Many people have ever failed this class.

c. First argument of *every*
   (i) Everyone who ever read a book got a prize.
   (ii) *Everyone who read a book ever got a prize.

An important generalization of these environments is that they are all Downward-entailing (DE) contexts (Ladusaw 1979). A DE context is a context that reverses the direction of entailment and licenses set-to-subset inferences. Consider *every*. From (39-a), we see that *every* is DE in its first argument position—from the fact that everyone who read a book got a prize we can infer that everyone who read a good book got a prize, with $\lambda x. [x$ read a book] being a superset of $\lambda x. [x$ read a good book]. In parallel, from (39-b) we see that *every* is upward-entailing (UE) in its second argument position. Formally, DE is defined in (40).

(39) **DE: EVERY**

a. first argument of *every*: set-to-subset
   Everyone [who read a book] [got a prize]
   $\subseteq$
   Everyone [who read a good book] [got a prize]

b. second argument of *every*: subset-to-set
   Everyone [who has read a book] [got a prize]
   $\supseteq$
   Everyone [who has read a book] [got a big prize]

(40) **DE** [von Fintel 1999: 100]

A function $f$ of type $\langle \sigma, \tau \rangle$ is DE iff for $a, b$ of type $\sigma$ such that $a \subseteq b$: $f(b) \subseteq f(a)$.

The reader can check that all the environments that license *ever* are DE. We thus have a generalization that a NPI is only grammatical if it is in the scope of an $\alpha$ such that $[\alpha]$ is DE (von Fintel 1999: 100).

Within Chierchia’s framework one finds a very neat explanation for the DE-generalization of NPIs. The basic idea is that NPIs such as *ever* are existentials.

---

11 *Irgendein* is chosen as an illustration because the facts are relatively clear and “irgendein seems to constitute the simplest element of the Polarity System” (Chierchia 2013: 255).
that obligatorily trigger alternatives, which can only be exhaustified successfully in DE-contexts.

Specifically, *ever* is an existential quantifier over times (of type $\langle \langle \tau, t \rangle, t \rangle$), just like *sometimes* (Chierchia 2013: 29). Being a quantifier, *ever* comes with a covert domain restriction variable (von Fintel 1994) ranging over properties of times and is represented as $T$ in (41).

\[(\text{ever}_T) = \lambda P_{\langle \tau, t \rangle} \exists t \in T[P(t)]\]

Different from *sometimes*, *ever* obligatorily triggers alternatives; in particular, it triggers sub-domain alternatives—alternative existential quantifiers with domain $T'$ being subset of the original $T$, as in (42).

\[\left[\text{ever}_T\right]_{D-Alt} = \{ \lambda P_{\langle \tau, t \rangle} \exists t \in T'[P(t)] : T' \subseteq T \}\]

Alternatives, once activated, must be exhaustified. In the case of *ever*, it is the $\mathcal{E}xh_o$ in (34) that does the exhaustification. Now consider the pair in (38-a): with (covert) $\mathcal{E}xh_o$ and domain variables, they have the following LFs.

\[(\text{43}) \text{ ALTERNATIVES- &- EXHAUSTIFICATION: ever} \]

\[\text{a. } \mathcal{E}xh_o \quad [I \text{ do not ever}_T \text{ vote republican}] \]

\[\text{PREJACENT: I do not vote republican at some } t \text{ in } T. \]

\[\text{APPLICATION of } \mathcal{E}xh_o \text{ is trivial.} \]

\[\text{b. } \mathcal{E}xh_o \quad [I \text{ ever}_T \text{ vote republican}] \]

\[\text{PREJACENT: I vote republican at some } t \text{ in } T. \]

\[\text{APPLICATION } \mathcal{E}xh_o: \forall T' \subseteq T, \text{ I do not vote republican at some } t \text{ in } T'. \]

It turns out that a computation of the meaning of (43-b) returns a contradiction. This is because that $I \text{ vote republican at some } t \text{ in } T$ (the prejacent of $\mathcal{E}xh_o$) entails that there is a $T' \subseteq T$ such that $I \text{ vote republican at some } t \text{ in } T'$. The latter contradicts the result of exhaustification using $\mathcal{E}xh_o$, according to which $I \text{ do not vote republican at some } t \text{ in any (strict) sub-domains of } T$. This contradiction explains why *ever* cannot be used in a positive context (see Gajewski 2002 for ungrammaticality caused by contradictions).

On the other hand, in (43-a), the exhaustification of $\mathcal{E}xh_o$ does not cause a problem, because the prejacent (that $I \text{ do not vote republican at some } t \text{ in } T$) now entails all the other alternatives (that $I \text{ do not vote republican at some time in } T'$, where $T' \subseteq T$). Applying $\mathcal{E}xh_o$ simply returns the prejacent and no contradiction results. This explains why *ever* can be used under negation.

In general, the above discussion establishes that NPIs like *ever* can only be used in DE contexts (where exhaustification does not return a contradiction for lack of stronger alternatives). The DE generalization of NPIs is thus explained in Chierchia’s system.

$^{12}$ $\tau$ is the type of times, and our semantic domains need to be enlarged with a set of time points/intervals. Sentences now receive truth-values relative to an assignment, a world and a time.
We just saw that domain alternatives play an important role in the explanation of weak NPIs such as *ever*. Besides *ever*, there are polarity items across languages with very different behaviors. Varieties of alternatives help us understand this variation in Chierchia’s framework. Consider German *irgendein*. As shown below, *irgendein* can be used in negative contexts, behaving like a simple negative polarity item such as English *ever* and *any* (on its NPI use), as in (44-a). It can also appear below a modal, triggering a free choice effect—*any professor is an option*—in (44-b). Finally, when it appears in episodic contexts, it triggers an epistemic effect—in (44-c) the speaker conveys that s/he “doesn’t know or care about who called, or thinks the identity of the speaker is irrelevant” (Kratzer and Shimoyama 2002: 9). If the context forces the absence of this epistemic effect, ungrammaticality ensues as in (44-d) (Chierchia 2013: 257).

(44) **German Irgendein**

a. **Negative contexts**

    Niemand hat irgendein Buch mitgebracht  
    No one had *IRGENDEIN* book brought along

    ‘No one brought along any book.’

b. **Modal contexts**

    Du darfst mit irgendeinem Professor sprechen  
    you can with *IRGENDEIN* professor speak

    ‘You can speak with any professor’

c. **Positive contexts with modal flavor**

    Irgendein Student hat angerufen  
    *IRGENDEIN* student has called

    ‘Some student called. For all the speaker knows, it might be any student.’

d. **Positive contexts without modal flavor**

    John has cheated. *Therefore *IRGENDEIN* student in your class is a cheater.

To explain the dual status of *irgendein* both as a NPI and a free choice item (FCI), Chierchia (following insights in Kratzer and Shimoyama 2002; Fox 2007a) proposes to use *pre-exhaustified sub-domain alternatives*. Let me first briefly introduce the notion of pre-exhaustified sub-domain alternatives.

Recall how free choice implicatures are derived in the alternatives-&-exhaustification approach. The sentence *you can have fruit or cake* carries a free choice implicature that both fruit and cake are possible options, and the implicature is derived (discussed in the previous section) by exhaustifying alternatives such as *you can have fruit but not cake* and *you can have cake but not fruit*. These alternatives
are pre-exhaustified sub-domain alternatives—they amount to domain alternatives already exhaustified by $\delta x h_o (\approx only): you can only have fruit and you can only have cake.$\textsuperscript{13}

With this in mind, let’s see how irgendein is treated in Chierchia (2013). Chierchia takes irgendein to be an existential determiner (similar to some/a) that obligatorily activates two kinds of alternatives: scalar alternatives\textsuperscript{14} and domain ones (let’s side aside pre-exhaustified alternatives for the moment).

(45) 

\begin{align*}
\text{a. } & \left[\text{irgendein}_{D}\right] = \lambda P \lambda Q \exists x \in D[\text{one}(x) \land P(x) \land Q(x)] \\
\text{b. } & \left[\text{irgendein}_{D}\right]_{\sigma-Alt} = \\
& [\lambda P \lambda Q \exists x \in D[n(x) \land P(x) \land Q(x)]: n \in \mathbb{N}^+] \\
\text{c. } & \left[\text{irgendein}_{D}\right]_{D-Alt} = \\
& [\lambda P \lambda Q \exists x \in D'[\text{one}(x) \land P(x) \land Q(x)]: D' \subseteq D]
\end{align*}

Consider how the entry works with (44-b). Plugging in (45), we get (46-a) as the prejacent of the exhaustive operator, (46-b) as the scalar alternatives and (46-c) the domain alternatives.

(46) 

\text{Alternatives: (44-b)}

\begin{align*}
\text{a. } & \text{Prejacent: } \Diamond \exists x \in D[\text{one}(x) \land \text{professor} \land \text{speak.to}(you, x)] \\
\text{b. } & \text{Scalar Alternatives:} \\
& \{\Diamond \exists x \in D[n(x) \land \text{professor} \land \text{speak.to}(you, x)]: n \in \mathbb{N}^+\} \\
\text{c. } & \text{Domain Alternatives:} \\
& \{\Diamond \exists x \in D'[\text{one}(x) \land \text{professor} \land \text{speak.to}(you, x)]: D' \subseteq D\}
\end{align*}

Suppose there are three professors a, b, c, and we can represent the content of (46) equivalently as (47),\textsuperscript{15} where a/b/c abbreviate you speak with a/b/c. Note here that due to the equivalence between disjunction and existential quantification, $\Diamond (a \lor b)$ is equivalent to $\Diamond \exists x \in \{a, b\}[\text{speak.to}(you, x)].$

(47) 

\text{Alternatives: (44-b)}

\begin{align*}
\Diamond (a \lor b \lor c) & \quad \text{Prejacent} \\
\Diamond (a \lor b) & \quad \Diamond (b \lor c) & \quad \Diamond (a \lor c) \quad \text{D- Alternatives} \\
\Diamond a & \quad \Diamond b & \quad \Diamond c \\
\Diamond (a \land b \land c) & \quad \sigma- \text{Alternatives}
\end{align*}

\textsuperscript{13}Think of them as alternative assertions; that is, when uttering you can have fruit or cake, we are also considering alternative assertions such as $A = you can have fruit.$ A, as an assertion, is itself pragmatically enriched, which in the alternatives-&-exhaustification framework amounts to pre-exhaustified.

\textsuperscript{14}Scalar alternatives vary the numeral part of an existential. For example, the scalar alternatives of one/a are two, three, and so on.

\textsuperscript{15}In (47), I omit, following Chierchia (2013): 253, intermediate scalar alternatives $\Diamond (a \land b), \Diamond (b \land c), \Diamond (a \land c)$, since the derivation of the free choice inference below is not affected by this simplification.
Chierchia also assumes that the two types of alternatives can be exhaustified separately by two exhaustification operators $\mathcal{E}xhDA$ and $\mathcal{E}xhDA$, both of which have the same semantics as the exhaustification operator introduced in (34).

It turns out that while exhaustification over the scalar-alternatives gives rise to a sensible meaning—$\neg \Diamond (a \land b \land c)$, exhaustification over the domain-alternatives delivers $\neg \Diamond a \land \neg \Diamond b \land \neg \Diamond c$, which however contradicts the prejacent. So far this is exactly parallel to our discussion of ever in positive contexts (43-b).

It’s time for pre-exhaustified domain-alternatives to come into play. Pre-exhaustifying the domain alternatives in (47) gives rise to the alternatives in (48).

(48) **Pre-exhaustified Alternatives:** (44-b)

\[
\begin{align*}
\Diamond (a \lor b \lor c) & \quad \text{Prejacent} \\
\mathcal{E}xh_o \Diamond (a \lor b) & \mathcal{E}xh_o \Diamond (b \lor c) \mathcal{E}xh_o \Diamond (a \lor c) \quad \text{EXH-D Alternatives} \\
\mathcal{E}xh_o \Diamond a & \quad \mathcal{E}xh_o \Diamond b \quad \mathcal{E}xh_o \Diamond c \\
\Diamond (a \land b \land c) & \quad \sigma - \text{Alternatives}
\end{align*}
\]

We unpack the pre-exhaustified domain alternatives, as follows.

(49) **Unpacking Pre-exhaustification**

a. $\mathcal{E}xh_o \Diamond (a \lor b) = \Diamond (a \lor b) \land \neg \Diamond c$

b. $\mathcal{E}xh_o \Diamond (b \lor c) = \Diamond (b \lor c) \land \neg \Diamond a$

c. $\mathcal{E}xh_o \Diamond (a \lor c) = \Diamond (a \lor c) \land \neg \Diamond b$

d. $\mathcal{E}xh_o \Diamond a = \Diamond a \land \neg \Diamond b \land \neg \Diamond c$

e. $\mathcal{E}xh_o \Diamond b = \Diamond b \land \neg \Diamond a \land \neg \Diamond c$

f. $\mathcal{E}xh_o \Diamond c = \Diamond c \land \neg \Diamond a \land \neg \Diamond b$

None of the pre-exhaustified domain-alternatives in (49) are entailed by the prejacent, so they are all negated by the outer $\mathcal{E}xh_o$, as in (50).

(50) **Exhaustifying Pre-exhaustification**

a. $\neg (\Diamond (a \lor b) \land \neg \Diamond c)$

b. $\neg (\Diamond (b \lor c) \land \neg \Diamond a)$

c. $\neg (\Diamond (a \lor c) \land \neg \Diamond b)$

d. $\neg (\Diamond a \land \neg \Diamond b \land \neg \Diamond c)$

e. $\neg (\Diamond b \land \neg \Diamond a \land \neg \Diamond c)$

f. $\neg (\Diamond c \land \neg \Diamond a \land \neg \Diamond b)$

(50) is further logically equivalent to (51).

(51) **Exhaustifying Pre-exhaustification:** simplification

a. $\Diamond (a \lor b) \rightarrow \Diamond c$

b. $\Diamond (b \lor c) \rightarrow \Diamond a$

---

16See Chierchia (2013) 176–190, 277–280 for the difference between exhaustifying the entire set and exhaustifying separately.
The conjunction of (51) amounts to
\[ \Diamond a \leftrightarrow \Diamond b \leftrightarrow \Diamond c, \]
which not only is compatible with the prejacent \( \Diamond (a \lor b \lor c) \), but also produces the free choice effect in conjunction with the prejacent \(-\Diamond a \land \Diamond b \land \Diamond c\), every professor is an option. Again, this is exactly in parallel with the explanation of free choice implicatures given in (31). Thus Chierchia provides a unified account of both free choice implicatures and FCI, the only difference being that the former is optional while the latter obligatory.

Now we have seen how Chierchia accounts for the fact that *irgendein* is possible under a modal, triggering a free choice effect (44-b). Can it also appear without a modal? It turns out Chierchia predicts it cannot. Consider the alternatives *irgendein* triggers in a modal-less environment.

\begin{align*}
(52) \quad \text{PRE- EXHAUSTIFIED ALTERNATIVES: modal-less} \\

\begin{array}{c}
\text{PREJACENT} \\
\Diamond a \lor \Diamond b \lor \Diamond c \\
\Diamond x_h(a \lor b) \land \Diamond x_h(b \lor c) \land \Diamond x_h(a \lor c) \\
\Diamond x_h a \land \Diamond x_h b \land \Diamond x_h c \\
\sigma \text{- ALTERNATIVES} \\
a \land b \land c
\end{array}
\end{align*}

Exhaustifying the above alternatives produces a contradiction: conjoining \( a \lor b \lor c \) (the prejacent) with the result of exhaustification over the pre-exhaustified domain-alternatives \( a \leftrightarrow b \leftrightarrow c \) we get \( a \land b \land c \), which is in plain contradiction with the result of exhaustifying the scalar alternatives—\( \neg(a \land b \land c) \).

So modals are crucial: different from the modal-less case, \( \Diamond a \land \Diamond b \land \Diamond c \) (the free choice effect) and \( \neg\Diamond(a \land b \land c) \) (the scalar effect) is not a contradiction. The affinity to modality of *irgendein* is thus accounted for—*irgendein* needs modals to avoid exhaustification failure. This further has consequences for *irgendein* in episodic sentences such as (44-c). In these cases, a covert modal is inserted, which both save *irgendein* from exhaustification failure and produces a modal flavor (Chierchia 2013: 256–257). When modal qualifications are impossible as in (44-d), *irgendein* is deviant.

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17 A proof: suppose \( \Diamond a \) is true. Then (a) and (c) in (51) are true and their consequents \( \Diamond c \) and \( \Diamond b \) must also be true. Similarly for all other alternatives.

18 Here is a model for it (let’s assume there are exactly three worlds in the model):
\[
\begin{align*}
& w_1 \quad a \land \neg b \land \neg c \\
& w_2 \quad b \land \neg a \land \neg c \\
& w_3 \quad c \land \neg a \land \neg b
\end{align*}
\]
Also notice that with modals we can actually have real split exhaustification—we can exhaustify the scalar alternatives below the modal while keep the exhaustificaiton of the pre-exhaustified domain-alternatives above it. This will deliver a reading without the scalar implicature. See Chierchia 2013: 254 for details.
Finally, *irgendein* also appears below negation, acting like a canonical NPI without the free choice effect, as in (44-a), repeated below.

(53) **IRGEINDEIN:** NPI

a. Niemand hat *irgendein* Buch mitgebracht
   No one had IRGEINDEIN book brought along
   ‘No one brought along any book.’

b.  

\[
\neg(a \lor b \lor c) \quad \text{PREJACENT}
\]

\[
\mathcal{E}xh_o \neg(a \lor b) \quad \mathcal{E}xh_o \neg(b \lor c) \quad \mathcal{E}xh_o \neg(a \lor c) \quad \text{EXH- D- ALTERNATIVES}
\]

\[
\mathcal{E}xh_o \neg a \quad \mathcal{E}xh_o \neg b \quad \mathcal{E}xh_o \neg c
\]

\[
\neg(a \land b \land c) \quad \sigma\text{- ALTERNATIVES}
\]

where \( \mathcal{E}xh_o \neg(a \lor b) = \neg(a \lor b) \land c \), etc.

It turns out pre-exhaustification has no effect: the scalar alternative is entailed by the prejacent so it is not negated; all the pre-exhaustified domain-alternatives are *incompatible* with the prejacent (for example \( \neg(a \lor b) \land c \) is incompatible with \( \neg(a \lor b \lor c) \)), so the result of negating them (and conjoining them with the prejacent) will just return the prejacent. Exhaustification has no effect and no contradiction arises, and it is correctly predicted that *irgendein* is happy in negative contexts without triggering a free choice effect.

It’s time to summarize our brief discussion of German *irgendein* analyzed in Chierchia (2013). We saw from the above that the use of two types of alternatives—pre-exhaustified domain-alternatives and scalar alternatives—and their exhaustification provides a unified analysis for a wide range of properties of *irgendein*, including: its dual status of being both a NPI and a FCI, its free choice effect and its affinity to modals…. Varieties of alternatives indeed play an important role in the explanation of polarity items.

Furthermore, varieties of alternatives help us understand variations within the polarity systems. Consider *ever* and *irgendein* together. While *irgendein* is both a NPI and a FCI, *ever* is a pure NPI that remains ungrammatical in modal contexts. Varieties of alternatives provide a simple explanation: they activate different types of alternatives. Specifically, *irgendein* can trigger pre-exhaustified alternatives while *ever*’s domain alternatives cannot be pre-exhaustified; since pre-exhaustified alternatives are crucial in producing the free choice effect in modal contexts, *irgendein* but not *ever* can be a FCI in modal contexts.

I will end the discussion of the polarity system by exhibiting the following beautiful chart from Chierchia (2013: 367) which provides a very plausible typology of polarity items across natural languages. Without going into the details, it’s obvious that varieties of alternatives provide one of the two parameters based on which polarity items can vary. The other parameter involves modes of exhaustification, including choices of exhaustification operators, constrains on the exhaustification process etc.
## 2 Background

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<th>Modes of exhaustification</th>
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<tr>
<td><strong>WEAK</strong></td>
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<td>Only truth conditions count for exhaustification</td>
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<td><strong>STRONG</strong></td>
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<tr>
<td>i. Truth conditions + impl + presup. count for exhaustification ($O^S$)</td>
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<tr>
<th>Degree alternatives (emphatic NPIs)</th>
<th>Simple</th>
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<tr>
<td>E koii bhii, ek bhii, give a damn</td>
<td>E$^S$ sleep a wink</td>
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<tr>
<th>Simple D-alternatives (+σ-alternatives (pure NPIs))</th>
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<tr>
<td>O ever, mai, alcun</td>
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<tr>
<th>Exhaustified D-alternatives + Rich Scale (Total variation $\exists$-FCI)</th>
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<td>O irgendein, un qualsiasi NP (Total $\exists$–FCI/NPI)</td>
<td>$O^S$ ?</td>
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<th>Exhaustified singleton D-alternatives + Rich Scale (Partial variation $\exists$-FCI)</th>
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<th>Exhaustified D-alternatives + Reduced Scale ($\forall$-FCI)</th>
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<tbody>
<tr>
<td>O any ( Partial $\forall$–FCI/NPI without)</td>
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</table>

This ends our discussion of polarity. Next, we will consider varieties of alternative from a different perspective. Specifically, we are going to discuss plural alternatives and singular alternatives and operators that are sensitive to this distinction. To do this, we need to consider pluralities and questions first.

### 2.1.4 Pluralities

Besides singular individuals, natural languages also have expressions which intuitively refer to collections of individuals, such as *John and Mary* and *the students*. To model denotations of such expressions, plural individuals are to be introduced into the entity domain $D_e$. Following Link (1983), we take the domain of individuals $D_e$ to consist of singular individuals (atoms), and plural ones (sums), both being $e$-type entities. Furthermore, sums are formed out of atoms under the operation of sum-formation $\oplus$, which is associative, commutative and idempotent.

\[(54) \quad \text{SUMMATION} \]

- \[a. \quad (\alpha \oplus \beta) \oplus \gamma = \alpha \oplus (\beta \oplus \gamma) \quad \text{ASSOCIATIVE} \]
- \[b. \quad \alpha \oplus \beta = \beta \oplus \alpha \quad \text{COMMUTATIVE} \]
- \[c. \quad \alpha \oplus \alpha = \alpha \quad \text{IDEMPOTENT} \]
2.1 Semantic Assumptions

We take $D_e$ to be closed under summation (that is, for any $\alpha$ and $\beta$ in $D_e$, the sum $\alpha \oplus \beta$ is also in $D_e$). With $\oplus$, we can further define a partial order $\leq$ (reads “part of”) on the set of individuals $D_e$:

\[
\alpha \leq \beta \text{ iff } \alpha \oplus \beta = \beta
\]

We can also define atomic individuals as individuals that have no proper parts.

\[
\text{Atoms } \text{Atom}(\alpha) \text{ (reads “}\alpha\text{ is an atom”)} \text{ iff } \forall \beta \leq \alpha [\alpha = \beta]
\]

Together, $(D_e, \oplus)$ forms a complete atomic join semi-lattice (see Landman 1991 for details). A domain containing three (atomic) individuals John, Mary and Sue has the following structure.

\[
\text{Complete Atomic Join Semi-lattice}
\]

Assuming that only John and Mary are students, we would like to have the following intuitively plausible (extensional) denotations.

\[
\text{Denotations}
\begin{align*}
\text{a. } [\text{John and Sue}] &= j \oplus s \\
\text{b. } [\text{the students}] &= j \oplus m \\
\text{c. } [\text{student}] &= \{j, m\} \\
\text{d. } [\text{students}] &= \{j, m, j \oplus m\}
\end{align*}
\]

To compositionally derive the above denotations, I following Link (1983) take $\textit{and}$ to correspond to $\oplus$,\(^\text{19}\) and I take English singular nouns to refer to sets of atoms while plural nouns sets that include both sums and atoms (Zweig 2008). Specifically,

\(^{19}\text{This merelogical sum and is different from the logical boolean and that connects sentences. The current book is not in a position to offer a unified analysis of and. For analyses that take the boolean and to be the basic, see (Winter 2001; Champollion 2015b). For analyses that take the sum and to be the basic, see (Krifka 1990; Heycock and Zamparelli 2005), and recently Fine (2015), from which I quote “and is essentially mereological rather than logical in character; and, whether it is used to connect nominal or sentential expressions, will signify fusion”.
}
we can derive the denotation of the latter from the former by assuming the plural morphology -s to be the sum-closure operator * (Link 1983).

\[(59)\]  
\[\ast P \text{ is the smallest set such that:} \] 
\[P \subseteq \ast P \text{ and} \] 
\[\forall x, y \in \ast P : x \oplus y \in \ast P \] 

\[(60)\]  
\[\llbracket \text{students} \rrbracket = \ast \llbracket \text{student} \rrbracket \]

Finally, following (Sharvy 1980; Link 1983) I take the to be a presuppositional generalized \(\bigoplus\).\(^{20}\) As in (61), the \(P\) is defined only if \(\bigoplus P \in P\), and if it is defined, the \(P\) denotes \(\bigoplus P\). Consider the model we described above: the student is not defined since \(\bigoplus \text{student} = j \oplus m\), which is not a member of student. On the other hand, the students is defined and denotes \(j \oplus m\), since \(\bigoplus \text{students} = j \oplus m\), which is also a member of students. Uniqueness is captured.

\[(61)\]  
\[\llbracket \text{the} \rrbracket = \lambda P : \bigoplus P \in P. \bigoplus P\]

This completes the background on pluralities.

2.1.5 \textbf{Questions}

The truth-conditional semantic framework we use cannot make sense of interrogative sentences yet, since interrogative sentences do not seem to have truth-conditions.

2.1.5.1 Questions as Sets of Propositions

We adopt a Hamblin/Karttunen semantics of questions (Hamblin 1973; Karttunen 1977), where a question denotes a set of propositions—the set of its possible answers. To illustrate, suppose that there are exactly three people besides Zhangsan in the domain, Bill, Mary and Sue, and that inviting is irreflexive; then the question in (1) denotes the set of propositions in (2).

\[(62)\]  
Who did Zhangsan invite?
\[
\{ \lambda w.z \ \text{invited} \ b \ \text{in} \ w, \\
\lambda w.z \ \text{invited} \ m \ \text{in} \ w, \\
\lambda w.z \ \text{invited} \ s \ \text{in} \ w, \}
\]

\[(63)\]  
\[\llbracket (1) \rrbracket = \{ \lambda w.z \ \text{invited} \ b \oplus m \ \text{in} \ w, \\
\lambda w.z \ \text{invited} \ m \oplus s \ \text{in} \ w, \\
\lambda w.z \ \text{invited} \ b \oplus m \oplus s \ \text{in} \ w, \}
\]

\(^{20}\bigoplus P := \alpha \text{ such that } \alpha = \alpha_1 \oplus \alpha_2 \oplus \alpha_3 \oplus \ldots \text{ for all members } \alpha_i \text{ in } P. \text{ I also use a colon and a period to enclose materials that is presupposed, following Heim and Kratzer 1998.} \]
2.1.5.2 Question-Answer Congruence

Treating questions as sets of propositions leads us to a neat characterization of the condition on question-answer congruence (Rooth 1992).

(64) **Question-Answer Congruence**

- Q₁: Who did John invite?
  - A₁: John invited Mary
  - A₁': #John invited Mary
- Q₂: Who invited Mary?
  - A₂: #John invited Mary
  - A₂': John invited Mary

As is shown in (64), a congruent answer to a *wh*-question must have *F*-marking (indicated by prosodic prominence) on the constituent corresponding to the *wh*-phrase.

Taking questions to be sets of propositions and *F* to trigger alternatives (Sect. 2.1.2) provides us with the condition in (65)

(65) **Q-A Congruence**

\[
[Q] \subseteq [A]_{Alt}
\]

In words: the denotation of the question has to be a subset of the alternative semantic value of its answer.

Since \([Q₁] \subseteq [A₁]_{Alt}\) but \([Q₁] \not\subseteq [A₁']_{Alt}\), \(A₁\) but not \(A₁'\) is a felicitous answer to \(Q₁\).

The same explanation applies to \(Q₂\) and \(A₂/A₂'\).

2.1.5.3 Answerhood Operator and Varieties of Alternatives

There are not only matrix questions but also embedded questions.

(66) John knows \([Q \text{ who Zhangsan invited}]\).

What does the question in (66) denote? Taking it to be a set of propositions (of type \(\langle st, t \rangle\)) seems problematic, since it predicts that *know* takes a set of propositions as its first argument—*know* will be of type \(\langle \langle st, t \rangle, \langle e, t \rangle \rangle\). But *know* also takes propositions, it should be of type \(\langle e, \langle st, t \rangle \rangle\) according to (67).

(67) John knows that Zhangsan invited Mary and Sue.

The standard solution is to assume the existence of answerhood operators (Heim 1994; Dayal 1996; Beck and Rullmann 1999). Answerhood operators mediate between *know* and its embedded question, reduces the latter to a propositional type, and thus allow for a unified analysis of *know* as of type \(\langle e, \langle st, t \rangle \rangle\). (68) is Dayal’s (1996) answerhood operator.
\[
\text{ANS}_w(Q) = \{ p \in Q \mid p(w) = 1 \land \forall q \in Q[q(w) = 1 \rightarrow p \subseteq q] \}
\]

Given an evaluation world \(w^\ast\), applying \(\text{ANS}_w\) to a question \(Q\) gives us the most informative proposition \(p\) in \(Q\) that is also true in \(w^\ast\), if there is such a \(p\) (if no such \(p\) exists, \(\text{ANS}_w(Q)\) is undefined).

To illustrate, let’s still suppose that there are exactly three people besides Zhangsan in the domain, Bill, Mary and Sue, and that inviting is irreflexive; next, let’s suppose Zhangsan invited Bill and Mary but not Sue in the actual world. Then the question in (1) (who did Zhangsan invited?) has the following shape, with true propositions underlined.

\[
\text{[[1]]} = \begin{cases}
\lambda w. z \text{ invited } b \text{ in } w, \\
\lambda w. z \text{ invited } m \text{ in } w, \\
\lambda w. z \text{ invited } s \text{ in } w, \\
\lambda w. z \text{ invited } b \oplus m \text{ in } w, \\
\lambda w. z \text{ invited } m \oplus s \text{ in } w, \\
\lambda w. z \text{ invited } b \oplus s \text{ in } w, \\
\lambda w. z \text{ invited } b \oplus m \oplus s \text{ in } w,
\end{cases}
\]

Within the true propositions, there is the most informative one \(\lambda w. z \text{ invited } b \oplus m \text{ in } w\), boxed in (69). Because of the existence of this most informative true proposition, \(\text{ANS}_{w^\ast}(Q(1))\) is defined and it is the boxed proposition. Now \(\text{know}\) can take this proposition as its argument, with the semantic representation of (66) being \(\text{know} (j, \text{ANS}_{w^\ast}(Q(1)))\).

There is another nice feature about Dayal’s answerhood operator. It captures questions’ uniqueness presuppositions. Consider the following paradigm.

(70)  
a. Which person did Zhangsan invite?  
b. Who did Zhangsan invite? 

(71)  
a. Zhangsan invited Bill. 
b. Zhangsan invited Bill and Mary.

Above, (70-a) can only be felicitously answered by (71-a), which names a single person. On the other hand, (70-b) can be answered either by (71-a) or (71-b). In other words, while (70-a) has a uniqueness presupposition that there was exactly one person that Zhangsan invited, (70-b) does not. Let’s see how Dayal’s answerhood operator captures this contrast.

First, assuming that singular \(wh\)-phrases such as which person ranges over atomic individuals while number-neutral ones such as who ranges over both atoms and sums, we have the following denotations for the two questions in (70): \(\text{[[70 - a]]}\) corresponds to an atom-based propositional set while \(\text{[[70 - b]]}\) a sum-based one.

\[
\text{[[70 - a]]} = \begin{cases}
\lambda w. z \text{ invited } b \text{ in } w, \\
\lambda w. z \text{ invited } m \text{ in } w, \\
\lambda w. z \text{ invited } s \text{ in } w,
\end{cases}
\]
2.1 Semantic Assumptions

\[ (70 - b) = \begin{cases} 
\lambda w. z \text{ invited } b \text{ in } w, \\
\lambda w. z \text{ invited } m \text{ in } w, \\
\lambda w. z \text{ invited } s \text{ in } w, \\
\lambda w. z \text{ invited } b \oplus m \text{ in } w, \\
\lambda w. z \text{ invited } m \oplus s \text{ in } w, \\
\lambda w. z \text{ invited } b \oplus s \text{ in } w, \\
\lambda w. z \text{ invited } b \oplus m \oplus s \text{ in } w. 
\end{cases} \]

It turns out that Dayal’s answerhood operator is sensitive to the atom-sum distinction of its question argument. Suppose in the actual world Zhangsan invited Bill and Mary but not Sue. \( \text{Ans}_{w*}(Q_{(70-b)}) \) is defined but \( \text{Ans}_{w*}(Q_{(70-a)}) \) is not. This is because in \( [(70 - a)] \) there are exactly two true propositions (\( \lambda w. z \text{ invited } b \text{ in } w \) and \( \lambda w. z \text{ invited } b \text{ in } w \)), neither one is more informative than the other; thus there is no proposition that is the most information one, and \( \text{Ans}_{w*}(Q_{(70-a)}) \) is not defined. On the other hand, as was discussed above, there is a proposition in \( \text{Ans}_{w*}(Q_{(70-b)}) \) - \( \lambda w. z \text{ invited } b \oplus m \text{ in } w \) - that is the most information proposition, and thus \( \text{Ans}_{w*}(Q_{(70-b)}) \) is defined. In general, \( \text{Ans}_{w*}(Q_{(70-a)}) \) is defined only if there is a unique person that Zhangsan invited, while \( \text{Ans}_{w*}(Q_{(70-b)}) \) does not have this restriction.

Finally, if we assume that a question \( Q \) always presupposes that \( \text{Ans}_{w*}(Q) \) is defined, that is, its Dayal-answer exists, the uniqueness presupposition of (70-a) (and the lack of it in (70-b)) is captured.

In sum, we have identified more varieties of alternative, this time, atom-based ones and sum-based ones, which can be directly read off the morphological composition of a question. We also saw that there are alternative sensitive operators such as Dayal’s answerhood operator that are sensitive to the atom-sum distinction. The two components together explain the uniqueness presuppositions of questions.

My analysis of the Mandarin focus particle system, as will be clear, is greatly inspired by Dayal’s answerhood operator.\(^{21}\) In Chap. 3, varieties of alternatives—in particular, atom-based ones and sum-based ones—will be posited to be associated with alternative sensitive operators, which again are sensitive to the atom-sum distinction of their alternative sets. The combination of the two features will be shown to explain several puzzling phenomena concerning Mandarin focus particles. Systematic ambiguities within the Mandarin focus particle system will receive a principled explanation.

\(^{21}\)I thank Roger Schwarzschild for first pointing out the significance of Dayal’s answerhood operator to my project.
2.2 Syntactic Assumptions

I briefly spell out my syntactic assumptions in this section.

2.2.1 Adverbial Status

I claim that *jiu* and *dou* are adverbs that adjoin to the Extended Verbal Projections (Grimshaw 1991) such as VP, TP. It differs from English *only* in that it never adjoins to arguments (such as DPs); in this respect, *jiu* is similar to German focus particles such as *nur, auch* and *sogar* (‘only’, ‘also’, ‘even’) (Büring and Hartmann 2001).

Below, (74-a), (74-b) and (74-c) illustrate the above claim for *jiu*. Crucially, (74-c) is bad because *jiu* cannot adjoin to a DP.

(74) a. \[TP \text{jiu} \ [TP \text{Yuehan qing le Lisi }].\]
\[\text{JIU John invite ASP Lisi}\]
‘Only John invited Lisi.’\text{ Adjunction to TP}

b. Yuehan [VP jiu [VP qing le Lisi ]].
\[\text{John jiu invite ASP Lisi}\]
‘John only invited Lisi.’\text{ Adjunction to VP}

c. *Yuehan qing le [DP jiu [DP Lisi ]].
\[\text{John invite ASP jiu Lisi}\]
Intended: ‘John invited only Lisi.’\text{ *Adjunction to DP}

Additional evidence supporting *jiu*’s adverbial status comes from the fact that it never appears within simple nominal arguments. This differs from English *only* which is able to appear within DPs acting as an adjective. To get an adjectival *only* in Mandarin Chinese, a different item *weiyi* ‘only’ has to be used (75-c) (the *de* below is just a modification marker that occurs between a modifier and the nominal it modifies).

(75) ADJECTIVAL-ONLY
a. John is the only teacher.

b. *Lisi shi zhi/jiu \text{ de laoshi}.\]
\[\text{Lisi BE only/\text{JIU DE teacher}\]
Intended: ‘Lisi is the only teacher.’

c. Lisi shi weiyi \text{ de laoshi}.\]
\[\text{Lisi BE only \text{ DE teacher}\]
‘Lisi is the only teacher.’

*Dou* behaves in exactly the same manner.
2.2 Syntactic Assumptions

2.2.2 Focus Association and Covert Movement

Both jiu and dou can be associated to its left. In these cases, I assume that they covertly move to the top of the structure and have scope over their associates, similar to even-movement. A LF is given in (76).

(76) Tamen dou mai.le yi.bu chezi
they DOU buy.ASP one.CL car
‘They each bought a car.’

A proposal is given in Sect. 3.3.1 that explains how and why jiu can be associated to its left on the surface. No explanation is attempted as for why dou is required to be associated to its left. See (Lin 1998; Yang 2001; Liao 2011) for some discussions.

This concludes my discussion of the background assumptions adopted in the book. In the next chapter we will see how the semantic tools and ideas presented here provide a unified account of Mandarin jiu, dou, and systematic ‘ambiguities’ of the Mandarin focus particle system.

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