

Chapter 1

From lexical semantics to cognitive psychology, and back again

Let us assume as a working hypothesis that s-selection can determine the projection of syntactic structure. Projection from lexical semantics presupposes the existence of a theory that predicts syntactic structure from lexical meaning without circularity. Finding such a theory was the initial goal of the research reported in this book. Section 1 documents this search, summarizing a state-of-the-art article by Levin and Rappaport-Hovav, where they show how the mapping of lexical semantics into syntax is plagued with inconsistencies and empirical problems. The conclusion drawn from these problems will be that a theory of lexical semantics must be firmly embedded in theories on adjacent domains, the hypothesis being that a proper delineation of domains can eliminate most of the problems.

Section 2 undertakes an excursion into cognitive psychology. The conclusion of section 2 will be that the powerful compositional apparatus assumed in much work on the lexicon is neither necessary, nor desirable. Linguistic complexity is a product of syntax, and event representations are computed by central sub-systems of a modular mind, a *commonsense theory of body movements (folk physics)*, and a *commonsense theory of mind mechanisms (folk psychology)* (Leslie 1994). Each of these components delivers a fundamental distinction, the one between agents and patients. Thus, the lexical entry of a verb must specify for each of its arguments: (i) whether it should be assigned to *folk psychology*, to *folk physics*, or to both for interpretation, and (ii) whether it is an agent, or a patient in the respective domain.

The remainder of section 2, and section 3 are dedicated to the feature-notation developed in Reinhart (2000), which matches the demands just outlined.

1. Lexical semantics: an overview

An important question in lexical semantics is figuring out which aspects of word meaning are relevant for argument expression. Pesetsky (1995:13) for

example observes that, “though there are doubtless relevant and identifiable distinctions between *shout* and *whisper* [...], these distinctions probably play no role at all in syntax/semantics interactions.” Other semantic distinctions do play such a role. I will refer to the question of identifying relevant distinctions as the *properties problem*.

Another, equally important question is how these distinctions are encoded such that both the computational system and the semantic component can read them. This question will be referred to as the *interface problem*.

A third question is how lexical relations are represented in syntax: the *mapping problem*.

This section gives an overview of some major approaches to these topics. Unless otherwise indicated, I will follow a manuscript by Levin and Rappaport Hovav (1996), henceforth L&R (1996).

1.1. Thematic role lists

An assumption that is common in both the semantic and the syntactic literature is that the meaning of a verb specifies the nature of the arguments it requires in the form of a list of role-predicates. In semantics, this assumption was pioneered by Castañeda (1967) in what has come to be known as the neo-Davidsonian view. On this view, arguments and adjuncts are introduced by independent predicates, as illustrated in Kratzer's (1996:109) example:

- (1) a. *We bought your slippers in Marrakesh.*
 b. $\exists e$ [*buying*(*e*) & *Agent*(*we*)(*e*) & *Theme*(*your slippers*)(*e*) & *in* (*Marrakesh*)(*e*)]

In syntax, most uses of the term *theta-role*, especially the widely shared formulation of the *Theta-Criterion* in (2), presuppose a role-list approach.¹

- (2) **Theta Criterion** (Chomsky 1981:36)
 Each argument bears one and only one Θ -role, and each Θ -role is assigned to one and only one argument.

Theta role lists thus appear to supply a straightforward answer to the *interface problem*. They are selected into a syntactic derivation in conjunction

with the verb they are part of, and then handed over to semantics. The question, of course, is whether such lists are empirically adequate.

Thematic role list approaches share the assumption that natural classes of verbs can be established on the basis of the number and kind of arguments a given verb takes. To illustrate this point, Levin and Rappaport Hovav (1996) sketch Fillmore's discussion of *break*- and *hit*-type verbs (Fillmore 1970).

Both *hit* and *break* verbs have agentive and non-agentive transitive alternants:

- (3) a. *John broke the window with a rock.*
 b. *John hit the fence with a stick.*
- (4) a. *A rock broke the window.*
 b. *A stick hit the fence.*

However, only *break* verbs have an unaccusative alternant. *Hit* verbs lack such a use:

- (5) a. *The window broke.*
 b. **The fence hit.*

This difference is related, according to Fillmore (1970), to a difference in the thematic (case-) roles the respective verbs have to assign. The *break* class selects an *Object*, which can appear as (unaccusative) subject. The *hit* class selects a *Place*, which cannot.

In striking contrast to its ubiquitous use outside lexical semantics, the thematic role list approach faces severe criticism in lexical semantics. Its problem is its arbitrariness, and it surfaces in three facets.

First, and this is reflected by the vast differences in roles assumed, there are no reliable tests for identifying a universally valid list of roles. Second, any given role list is just that. It cannot express relations among different roles that might be part of equivalence classes. Finally, we do not always find a clear correspondence between roles and argument positions: Some arguments appear to bear more than one role, and some roles appear to be assigned to more than one argument.

The universal list problem was discussed in great detail by Dowty (1991), who states that

[t]he dilemma is, if we adopt the finer characterization of roles to achieve certain distinctions, do we not thereby miss generalizations by not being able to refer to the grosser [...] category as well? (Dowty 1991:554)

Levin and Rappaport Hovav (1996) exemplify the dilemma with their notion of *immediate cause*, which figures in their lexicon-syntax mapping rules. *Immediate cause* is a very broad concept, including *agents*, *causes*, and even *emitters* in verbs of sound and light emission, but it does have consistent meaning, and its syntactic realization is likewise predictable. Immediate causes are always realized as subjects. The notion therefore qualifies as an excellent candidate for a thematic role.

On the other hand, some constructions require finer grained distinctions. For example, *emitters* appear in the locative inversion construction, *agents* usually do not (examples from Levin and Rappaport Hovav 1995:255).

- (6) a. **In the factory worked young boys at the age of 7.*
- b. *And in their wake rumbled trucks to haul off the remains.*

A thematic role list approach has no way to state both the subject- and the locative inversion-generalization without contradiction.

This leads to the second aspect of the problem. It might be suggested that *agents*, *causes* and *emitters* are thematic roles, and that they form a natural class of *immediate causes*. *Immediate cause* might thus be a super-role that can itself feature in generalizations. However, such a move is excluded under the thematic role list approach: “there is nothing in a semantic role list which tells us that there is anything which unifies” (L&R 1996:14) the members of whichever super-role we might want to postulate.

The *proto-roles* in Dowty (1991) are designed to avoid this problem, however at a cost. First, the entailments related to *proto-agents* and *proto-patients* are arbitrary lists again. While they might be doing a fair job describing natural classes of verbs, Dowty (1991) offers no clue as to how those entailments derive from the meaning of a given verb. And second, *proto-roles* give rise to the grosser generalizations, mainly subject-object asymmetries, while offering no tool to handle finer grained distinctions among smaller classes. We will return to this proposal in the discussion of mapping theories.

Simple thematic role lists are motivated to a large extent by their behavior in the lexicon-syntax mapping. Roughly, we would find a similar behavior of a class of verbs with respect to an argument and a construction,

and we conclude from this similarity that the verbs in question share a thematic role.

Such a reasoning is called into question if it turns out that the lexicon-syntax mapping is not unique. Indeed it has been argued that the mapping is many-to-many. L&R (1996) quote Gruber (1965) and Jackendoff (1972) with the assumption that verbs of motion may assign both the *agent* and the *theme* role to their subject, and they give *resemble* as an example of a verb that assigns the same role to both the subject and the object.

I thus conclude with L&R (1996) that simple thematic role lists are not appropriate tools for the description of syntactically relevant lexical information.

1.2. Roles and events

According to a wide consensus among lexical semanticists, many of the above mentioned problems can be avoided, if the mental representation of events is taken into account. The properties of individual thematic roles should thus follow from a more general theory of event representation, which would also have to determine natural classes of roles.

Nevertheless, such an approach will still have to answer to the *properties problem*. Event representations have been suggested from various perspectives, and it is not a necessary truth that any one of them is most relevant for syntactic structure. In addition, this approach introduces the *interface problem*. In contrast to Θ -roles, there is no agreement as to how structured events are represented in syntax, and how exactly they are transferred into semantics. The event-representation approach introduces yet another manifestation of the *interface problem*, to be discussed in section 3: is a given lexical verb meaning a representation of, derived from, or identical with the mental representation of an event?

Let us first turn to the *properties* problem. In the literature on lexical semantics, we find three perspectives on how events are conceptualized, the *localist*, the *aspectual*, and the *causal* approach.

1.2.1. The localist approach

On the localist approach, which was pioneered by Gruber (1965), there are two basic event types, *motion* and *location*, from which all other event

types are derived. In other words, it is assumed that we conceptualize all events as spatial metaphors. Jackendoff (1983) summarizes this approach in his *Thematic Relations Hypothesis*.

- (7) Thematic Relations Hypothesis (Jackendoff 1983:188)
 In any semantic field of events and states, the principal event, state, path, and place functions are a subset of those used for the analysis of spatial motion and location.
 Fields differ in only 3 possible ways:
- what sorts of entities may appear as theme
 - what sorts of entities may appear as reference objects (i.e., locations)
 - what kind of relation assumes the role played by location in the field of spatial expressions.

An advantage of this approach is that it can account for cases of systematic polysemy, as in the following example, where the object NP of a single verb receives quite different thematic interpretations (L&R 1996:21):

- (8) a. *John kept the car in the garage.*
 b. *John kept the book.*
 c. *John kept Andy happy.*
- (9) [CAUSE (x, (STAY y,z))]

On the localist approach, all of these interpretations can be derived from a single representation (9) of the verb *keep*, which is realized in different semantic fields: the positional field in (8a), the possessional field in (8b), and the identificational field in (8c).

The main problem of the localist approach is that local relations do not seem to be directly relevant for the realization of lexical-semantic roles in syntactic argument positions. Acknowledging this fact, Jackendoff (1990) introduces an *action tier* that takes precedence over the *thematic tier* in the selection of subjects and objects. While the *thematic tier* encodes local relations, the *action tier* encodes causal relations like *agent* vs. *patient*. The precedence of the action tier with respect to grammatical functions indicates that the causal approach is more adequate in the investigation of the lexicon-syntax interaction than the localist approach.

1.2.2. The aspectual approach

The aspectual approach to argument realization has received a lot of attention recently because of its *prima facie* plausibility. First, the notions it introduces, *measuring out* and *delimitation* are much smaller in scope than traditional listed Θ -roles. Second, the event participants designated by these notions largely correspond to internal arguments, which makes them a good tool to describe the lexicon-syntax interaction.

Tenny (1994) summarizes the foundations of the aspectual approach in her *aspectual interface hypothesis*:

(10) Aspectual Interface Hypothesis (Tenny 1994:2)

The universal principles of mapping between thematic structure and syntactic structure are governed by aspectual properties. Constraints on the aspectual properties associated with direct internal arguments, and external arguments in syntactic structure constrain the kinds of event participants that can occupy these positions. Only the aspectual part of thematic structure is visible to the universal linking principles.

Unfortunately, the aspectual approach suffers from a number of loose ends. Take first the generalization that telic intransitives are unaccusative (Dowty 1991; Hoekstra 1984; van Valin 1990). Borer (1994) extends this generalization to derive unaccusativity from telicity.

However, Levin and Rappaport Hovav (1995:172ff). show that certain verbs of directed motion like *descend*, *rise*, and degree achievement verbs like *cool*, *lengthen*, are both unaccusative and atelic. Atelicity is shown by the compatibility with durative *for* phrases and punctual *at* phrases:

- (11) a. *The temperature rose steadily for three hours.*
 b. *The temperature rose at one o'clock.*
- (12) a. *The soup cooled for half an hour.*
 b. *The soup cooled at three o'clock.*

Unaccusativity is shown for the motion verbs by their incompatibility with the *X's way* construction, and by the absence of cognate objects. For degree achievements, unaccusativity is shown by the fact that they have causative alternants, and by their incompatibility with the *X's way* construction:

- (13) a. **She rose her way to the presidency.*
 b. **She rose a wobbly rise.*
- (14) a. *The soup cooled.*
 b. *I cooled the soup.*
 c. **The soup cooled its way to room temperature.*

We can conclude from this evidence that telicity does not derive unaccusativity. This takes out a forceful argument in support of the aspectual approach.

Second, Jackendoff (1996) argues that *measuring out* and *delimitation* are sometimes determined by pragmatic, rather than lexical-semantic factors. Take as an example a predicate like *draw*. The object of *draw* is normally interpreted as an *event-measure*, or *incremental theme*: the fraction of the object drawn measures, so to say, the completeness of the drawing event. This is not the case, however, if an object is not drawn in the normal way, but, for example, sprayed on a piece of paper in one swoop by a printer.

The same holds for many other examples. When we eat an apple, the size of the remaining portion of the apple measures the completion of the event. But when we eat a grape, or even more so a raisin, it usually disappears at once, and therefore cannot measure the event.

On the aspectual approach, we would expect different argument realization patterns caused by an altered measuring behavior. This expectation is not borne out.

Third, Jackendoff (1996) argues that the aspectual approach fails to predict that certain affected objects, which do not necessarily measure out or delimit an event, are nevertheless realized as objects (15). Thus, affectedness (a causal notion), rather than delimitation, determines objecthood here.

- (15) *What John did to the bread was chew/ knead/ jiggle/ spin it.*

Forth, Tenny (1994) and Dowty (1991) claim that locative inversion excludes an agentivity reading, because NP must be generated as an object in this construction, and objects must measure (Tenny), or have proto-patient properties (Dowty). However, an agentive reading is possible, at least in some cases:

- (16) *Across my windowsill walked a whole army of ants.*

Finally, Reinhart (2000) argues against the very notions of *measurement* and *delimitation*. The intuitive nature of these notions, she claims, is responsible for much of their initial appeal, which evaporates, once they are semantically formalized. According to Reinhart (2000), the only aspectually relevant notion is *homogeneity*, which classifies both states vs. events, and mass vs. count nouns: states and mass nouns are homogeneous, events and count nouns are not.

Notice that homogeneity does not face Jackendoff's problem of duration above. If an event is homogeneous, it does not matter how much (or little) time it consumes on a given occasion: it can always be split in half, and is still the same event. In a non-homogeneous event, a part is never equal to the whole, no matter how short it might actually be on a given occasion.

In sum, the aspectual approach to argument realization does not stand up to closer scrutiny mainly for the same reason that underlies its initial appeal: the intuitive nature of the notions applied. Once pinned down to a falsifiable core, they lend themselves to fragmentary generalizations regarding argument structure, at the best.

1.2.3. *The causal approach*

Dealing with the localist approach, it has been shown that causal relations play a more important role in the realization of arguments than local relations. Within the causal approach, this intuition is taken as a starting point. Croft (1991, 1998), building on work by Talmy (1976, 1988), argues that causation is conceptualized as a transmission of force between event participants, and that "certain non-causal relationships are conceptualized as if they were asymmetric force-dynamic relationships" (Croft 1998:31).

Verbs, on this approach, name segments of a causal chain. In such a chain, "[o]ne participant outranks another if it is antecedent to the other on the causal chain" (Croft 1998:23). In this way, Croft derives a partial ordering of arguments that can be used in the mapping from lexical semantics to syntax.

An example of such an ordering is the distinction between antecedent and subsequent oblique roles. Antecedent roles are ranked high on the causal chain, and include instrumental, manner, means, comitative, cause. Subsequent roles are ranked low, and include benefactive, recipient, result.

Croft (1991) supports the distinction between antecedent and subsequent roles with case syncretisms, which appear inside a class, but not

across classes. In Croft (1998), he extends this generalization to acquisition, reporting a study by Clark and Carpenter (1989):

According to that study, when English children mistakenly use prepositions, they never substitute an antecedent preposition for a subsequent one, or vice versa, while they regularly mix up prepositions within a class. For example, they would substitute *by* for *with* in instrumentals, or *with* for *by* for passive agents (Croft 1998:40):

- (17) a. *I just eat it by my spoon.*
 b. *Sometimes Eva needs to be feeded with you because she doesn't eat.*

The causal approach seems to fare better than the local, or the aspectual approach in several respects. Take for one example causative change of state verbs. On the aspectual approach, such verbs are analyzed into two sub-events, an activity and a result state, which are connected by a causal relation. Nothing in the aspectual approach requires that the activity-phase and the result state must always share an argument (the affected object). The force-dynamic approach predicts this (L&R 1996:34).

L&R offer several more examples, where the causative approach seems superior to the aspectual one. The objects of activity verbs like *wipe*, *rub*, and another class: *jiggle*, *chew*, do not measure-out or delimit, so the aspectual approach does not predict that they must be realized as direct objects. The causal approach does, because force is applied to them.

The same holds for the locative alternation: (18a) means that Pat did something to, or with the paint, while (18b) is more readily read as Pat doing something to the wall.

- (18) a. *Pat sprayed paint on the wall.*
 b. *Pat sprayed the wall with paint.*

It seems to me, however, that the causal approach as it stands faces challenges too. As long as it is not embedded in, and derived from, a proper theory of mind mechanisms, the notion *force* remains intuitive. Its application to syntactic argument structure is vague, and hard to falsify. As an illustration, take psychological verbs of the *fear* class:

- (19) *Jörg feared a short blonde bloke with thin hair.*

In (19), it is well conceivable that force is emitted by the individual that triggers the fear, and that it is transferred to the individual denoted by the subject. In other words, there is a force-differential that places the direct object above the subject. If force-differentials were the only factor to determine syntactic argument structure, *fear* should behave like *frighten*, with the stimulus in subject- and the experiencer in object position.

(20) *A short blonde bloke with thin hair frightened Jörg.*

The force-dynamic approach offers an account of such problems, for example in terms of Croft's *verbal profiles*, which specify exactly which segment of the causal chain is denoted by a given verb. *Fear*-verbs might thus be taken to denote the emission of cognitive energy by the experiencer towards a representation of the stimulus. Another option would be to distinguish the roles *cause* and *subject matter of emotion* (Pesetsky 1995). However, since the cause of an emotion can also be its subject matter, it remains unclear, in which way force-dynamic relations have the potential to order thematic roles with respect to each other, rather than describing the dynamics of particular events.

Nevertheless, the causal approach seems to be the most promising strategy with respect to the *properties problem*: causal relations are robustly involved in the determination of grammatical functions. Where the causal approach faces problems, primarily with respect to psychological predicates, the rivaling approaches do not fare better.

As it stands, the causal approach does not supply an answer to the *interface problem*. It does not deliver a formalization of relevant properties that is both accurate and legible by the computational system. Neither is it embedded in an explicit theory about the relation between mental and linguistic representations. Before turning to that in section 3, let us take a quick look at how the *mapping problem* has been dealt with in the literature.

2. The mapping procedure

According to a widely held conjecture, compositional lexical semantic structure is preserved under the mapping of lexical items into syntax. This conjecture has been expressed in several different ways, the most general of which is the *Universal Alignment Hypothesis* (UAH) of Perlmutter and Postal (1984):

- (21) Universal Alignment Hypothesis (Perlmutter and Postal 1984:97 - from L&R 1996:37)

There exist principles of UG which predict the initial [grammatical] relation borne by each nominal in a given clause from the meaning of the clause.

The UAH states that there are unique grammatical realizations of thematic relations. This is not an innocent assumption, and indeed weaker formulations of the lexicon-syntax mapping can be found. One of them is Rosen's (1984) *Little Alignment Hypothesis* (LAH), which comes quite close to Chomsky's *Projection Principle* in one respect.

While the UAH assumes there are general properties of clauses from which lexical relations can be read off, both the LAH and the Projection Principle assume that individual lexical items have constant properties, which are not altered by the computational system, and indeed determine the way in which the item projects syntactically. The Projection Principle fundamentally differs from the LAH with respect to the properties it describes. The LAH talks about semantic roles, the Projection Principle about formal features, i.e. subcategorization. Chapters 2-4 will rely on the importance of this distinction.

- (22) The Little Alignment Hypothesis (Rosen 1984:53(45) - from L&R 1996:37)

For any one predicate in any one language, there is a fixed mapping which aligns each semantic role with an initial GR. The alignment remains invariant for all clauses with that predicate.

- (23) Projection Principle (Chomsky 1981:29)

Representations at each syntactic level (i.e., LF, and D- and S-structure) are projected from the lexicon, in that they observe the subcategorization properties of lexical items.

In spite its weakness, disallowing generalizations across predicate classes and languages, the LAH might still be too strong. It is not a given truth that the semantic roles assigned by a given predicate are always realized in an identical way. Therefore, lexical semanticists usually favor (some version of) the UAH. The discussion is more on the type of mapping, than on the question whether it is universal or not.

Turn first to *direct mapping* accounts. *Direct Mapping* means that lexical properties are translated into grammatical relations directly, without any mediating level of representation. Probably the most influential such account is given in Levin and Rappaport Hovav (1995), exemplified here with their *immediate cause linking rule*:

- (24) Immediate Cause Linking Rule (Levin and Rappaport Hovav 1995:135)

The argument of a verb that denotes the immediate cause of the eventuality described by that verb is its external argument.

As noted by Levin and Rappaport Hovav (1996), a disadvantage of direct mapping rules of this kind is that they are arbitrary. There is nothing in a direct mapping account that would tell us, for example, why an instrument (which is an immediate cause) is not linked to an external argument position, when an agent is present.

Mediated mapping approaches seek to deal with exactly this problem. Thematic role hierarchies are probably the best-known devices of mediated mapping. There is some agreement to the assumption that linking rules map the highest ranked argument to the subject position, and the lowest one to the object.

Thematic role hierarchies inherit several problems from the roles they order. Without clear criteria to distinguish particular roles, such roles are hard to rank with respect to each other. Worse still, it is extremely difficult to compare hierarchies based on different definitions of roles.

Over and above this, the proposed mapping rules make reference to the hierarchies in strikingly different ways, and these divergences also need to be factored into any comparison of the hierarchies. Unfortunately, we are unaware of thorough comparative assessments [...] (L&R 1996:44).

To illustrate this problem, consider the presentation of hierarchies in L&R (1996:43-44):

No mention of goal and location

Belletti and Rizzi (1988): Agt > Exp > Th

Fillmore (1968): Agt > Inst > Obj

Goal and location ranked above theme/patient

Grimshaw (1990): Agt > Exp > G/S/L > Th

Jackendoff (1972): Agt > G/S/L > Th

van Valin (1990): Agt > Eff > Exp > L > Th > Pat

Goal and location ranked below theme/patient

Speas (1990): Agt > Exp > Th > G/S/L > Manner/Time

Carrier-Duncan (1985): Agt > Th > G/S/L

Jackendoff (1990): Agt > Pat/Ben > Th > G/S/L

Larson (1988): Agt > Th > G > Obl

Baker (1989): Agt > Inst > Th/Pat > G/L

Goal above patient/theme; location ranked below theme/patient

Bresnan and Kanerva (1989): Agt > Ben > Rec/Exp > Inst > Th/Pat > L

Kiparsky (1985): Agt > S > G > Inst > Th/Pat > L

Givón (1984): Agt > Dat/Ben > Pat > L > Inst

Another approach to mediated mapping makes use of intermediate roles. The most influential proposal involving intermediate roles is developed in Dowty (1991). His *thematic proto roles* are lists of entailments. If a given argument gives rise to more proto-agent entailments than proto-patient entailments, it is realized as a subject. If the proto-patient entailments predominate, it is realized as an object.

Contributing properties for the Agent Proto-Role:

- a. volitional involvement in the event or state
- b. sentience (and/or perception)
- c. causing an event or change of state in another participant
- d. movement (relative to the position of another participant)
- (e. exists independently of the event named by the verb)

Contributing properties for the Patient Proto-Role:

- a. undergoes change of state
- b. incremental theme
- c. causally affected by another participant
- d. stationary relative to movement of another participant
- (e. does not exist independently of the event, or not at all)

(Dowty 1991:572)

Dowty (1991:572) gives these lists “without implying that [they] are necessarily exhaustive or that they could perhaps eventually be better partitioned in some other way”. In this sense, they just postpone the initial problem of explaining why particular roles are mapped on specific grammatical functions. They describe generalizations that we would want to follow from either the conceptualization of events, or from other factors. In this sense, they only re-state the well-known problem that grammatical functions are loosely related to the thematic properties of event descriptions.

2.1. Beyond the UAH

It is not unreasonable to suspect, based on the problems with direct and mediated mapping proposals, that such problems stem from too loose a conception of the lexicon-syntax mapping. Several authors adopt this strategy, and suggest mapping procedures that are more restricted than the UAH would predict them to be.

A first class of theories strengthens the UAH by adding the assumption that the lexicon-syntax mapping is isomorphic. The advantage of this move is the transparency of the operation. However, the abundance of lexical semantic distinctions necessitates substantial adjustments in the generation of syntactic structure, in order to maintain the isomorphism hypothesis. An example is the introduction of an entirely new level of representation, *lexical syntactic structure*, which is subject to slightly different wellformedness conditions than syntax proper, in the work of Hale and Keyser (1993, 1999).

More often than isomorphism, we find the assumption of a homomorphism between lexical and syntactic structure. A homomorphic mapping allows the realization of multiple lexical properties by a single grammatical function. An example of a homomorphic mapping approach is the *Uniformity of Theta Assignment Hypothesis* (UTAH) of Baker (1988):

- (25) The Uniformity of Theta Assignment Hypothesis (UTAH) (Baker 1988:46)

Identical thematic relationships between items are represented by identical structural relationships between those items at the level of d-structure.

Provided a given syntactic relationship can be identical to more than one thematic relationship, Baker's version of the UTAH allows the desired one-to-many mapping. One way to accomplish this is by formulating the lexicon-syntax mapping as structure preserving for relative prominence. The UTAH then roughly translates into the requirement that a prominence relation between two roles in the lexicon must be conserved in syntax. Several relativized versions of the UTAH make comparable assumptions (Belletti and Rizzi 1988; Larson 1988, 1990; Jackendoff 1990).

2.2. Problems with diathesis alternations

Theories based on homomorphic mapping can account for many-to-one relations between lexical and syntactic configurations, but diathesis alternations seem to require a relation from one lexical role to a variety of different syntactic functions. The mapping therefore must be many-to-many. A homomorphism does not allow many-to-many relations.

Such problems have been tackled from two perspectives. Either, lexical entries are viewed as constant in meaning, with diathesis alternations arising from grammatical transformations. This is the *projectional* approach. Or, lexical entries are viewed as massively ambiguous, with syntactic realization coercing constructional meaning on it, the *constructional* approach.

An example of where the first strategy has successfully been adopted is the passive alternation, which crucially does not affect the thematic relations of the arguments of a predicate.

- (26) a. *John ate the grape.*
 b. *The grape was eaten by John.*

The locative alternation is more problematic in this respect:

- (27) a. *The farmer loaded the hay on the truck.*
 b. *The farmer loaded the truck with hay.*

L&R (1996:60) point out that the two alternants exhibit a difference in meaning that can be accounted for in terms of lexical semantics: (27a) expresses a causative change of location. (27b) expresses a causative change of state.

If a theory based on the projectional approach maintains a single lexical entry for such verbs, it cannot account for the difference in meaning, unless it doubles lexical semantic structure in syntax. Generative Semantics did just that; see Fodor (1970) for why this approach is problematic: it forces the introduction of otherwise unattested, and largely arbitrary transformations.

This leaves us with the constructional approach, which is recently enjoying great attention (Borer 1994, 1998, 2000; Erteshik-Shir and Rapoport 1995; Ghomeshi and Massam 1995; Goldberg 1995; Hoekstra 1992; Ritter and Rosen 1996). On the constructional approach, the lexical content of a predicate is reduced to a minimum, which indeed remains constant across

different constructions, and thematic meaning is attributed to specific constructions.

As an illustration, take the lexical items *boat*, *dog*, *sink*. According to Borer (2000, 2003) (cf. Chapter 3 for details and discussion), these lexical items have a conceptual core meaning that is, kind of loosely, related to what we think of dogs, boats, and sinking. This conceptual meaning helps us interpreting utterances like those in (28):

- (28) a. The dog sank the boat.
 b. The boat dogged the sink.
 c. The sink boated the dog.

(28b) might be a rare utterance to come about, and (28c) seems even less likely to be ever produced. However, such unlikely sentences are interpretable. In (28b), we understand that a boat did something to a sink, and this event reminds us of the *dog*-concept. Similarly in (28c). A sink does something to a dog, and the event is reminiscent of boats.

On the constructional approach, syntactic structure is much more than a projection of lexical items. It supplies an event-structural template that forces thematic roles upon the lexical items inserted into them. Thus, the answer to the *mapping problem* offered by the constructional approach is trivial. There is no mapping of thematic information from the lexicon into syntax. What the constructional approach fails to give is a principled explanation of why particular syntactic configurations should have the assumed thematic properties. Borer (1994) and subsequent work attribute most of the explanatory burden to aspect. The limitations of this approach were discussed in section 1.2.2 above.

2.3. Summary

In sum, the three problems stated at the outset have been dealt with in the literature in rather inconsistent ways. A solution to the *properties problem* seems to call for a causal approach to lexical semantics, while the *interface problem* clearly favors thematic role lists, which are problematic on independent grounds. Given this disparity of requirements, it is hard to even start to answer the *mapping problem*. It might just as well turn out that there is a way of formalizing lexical knowledge and syntactic projection

such that the mapping problem must be addressed from a different perspective than the one taken in lexical semantics.

In the following subsection, I will evaluate the object of research, lexical semantic representation, in the light of recent developments in cognitive psychology. Building on a strictly modular theory of the mind, I will argue that thematic relations encode two fundamental concepts of a commonsense representation of events: mechanical and psychological agency. These concepts can be encoded as binary features (Reinhart 2000), which makes it possible to dispense with recursive mechanisms in the lexicon, and to answer the *interface problem*: by hypothesis, Reinhart's features are legible by the computational system, and they can be interpreted in semantics as neo-Davidsonian role predicates. Chapter 2 is dedicated to an empirical re-examination of the mapping problem with data from German.

3. The architecture of the mind, and the lexicon

In *Modularity of Mind*, Fodor (1983) defends the thesis that the mind can be analyzed into a central system of thought and highly specialized interface systems, by which the central system interacts with the outside world. One of these interface systems is the language faculty. Embedded in Fodor's model, language interfaces with the central system of thought on one end, and with the shallower systems of motor control and sensual input on the other end. So if we want to find out about the interface of language with thought, i.e., with the manipulation of concepts, as lexical semantics attempts to do, we need to find out which conditions the central system of thought imposes on the representation and manipulation of concepts.

However, in Fodor's theory, "conceptual processes [...] are presented as a big holistic lump lacking joints at which to carve", as Sperber (1994:39) puts it. If this approach is correct, then the most basic question of lexical semantics, what I called the *properties problem* above, cannot reasonably be addressed at all. The reason is that, on the view described by Sperber (1994), there is no single set of properties that characterizes the handling of concepts in the mind. If constraints on the lexical representation of concepts exist at all, then they must be specific to the language faculty. Research in lexical semantics indeed seems to be based on this assumption. A powerful lexicon shoulders the heavy burden of event representation. However, there is a much more elegant, and successful way to approach the problem.

3.1. The lexicon is a list: Fodor & Lepore

The existence of recursive mechanisms in the lexicon has been called into question by Fodor and Lepore (1998), henceforth F&L. According to F&L,

lexical entries are typically atomic [...]. [T]he only thing a lexical entry specifies is the denotation of the item it describes (Fodor and Lepore 1998:270).

They immediately relativize this strong position, granting that

lexical *entries* are typically complex. But we claim that they are complex in a way that does not jeopardize the thesis that lexical *meaning* is atomistic, or the identification of lexical meaning with denotation (Fodor and Lepore 1998:270; italics by F&L).

It is interesting to see exactly which aspects of lexical complexity F&L reject, and why they do so.

F&L consider inter-lexical relations, ambiguity, semantic wellformedness, and (apparent) syntactic effects of lexical complexity, and argue that none of these issues calls for lexical complexity in the sense that real-world relations among objects be represented by similar relations in the lexicon, or that the lexicon had recursive, generative, capacities like syntax.

First, words are related to other words in a way that can be captured by analytic inference. A *dog*, for example, is also an animal, and one might want to represent this fact as part of the meaning of *dog*. However, F&L argue, such facts are related to what a speaker knows (or believes, pretends, etc. to know) about the world, and not to structural properties of the lexicon. For example, the question whether a *tomato* is a *vegetable* or not, is answered in biology, not in the lexicon. The fact that a *dog* is an animal can be stated as part of its (arbitrary) denotation, like *has four legs*, *barks and bites*, *carries flees*, and a few other contingent truths about dogs. Any of these properties can be changed, and indeed reversed, without serious effect on the use of the word (Lewis 1981). In sum, inter-lexical relations do not support recursive procedures in the lexicon.

Second, lexical generativity is required, in the theories F&L attack, by the varying meanings a given lexical item may assume. They consider as an example the meaning of *bake* in *bake a cake* (creation) versus *bake a potato* (cook). The generalization here would be that *bake* assumes the meaning of creation when combined with an artifact, and that of cooking otherwise. The question is whether the lexicon should have the power to explicitly derive these two meanings.

Both conceptual economy and empirical fact militate against this. Different uses of a given lexical item are just as well compatible with lexical ambiguity and (partial) pragmatic disambiguation. Such an approach actually fares much better than the complex lexicon approach, once we consider the availability of half-baked bread in every supermarket (an artifact that is being cooked, not created).

[...] in fact, even assuming that the lexicon distinguishes artifacts from natural kinds is not enough. Notice that although *knives* and *trolley cars* are artifacts, *bake a knife* and *bake a trolley car* resist a creative reading quite as much as *bake a potato* does. But if *bake a cake* is heard as creative because *cake* is marked as denoting an artifact, then *bake a trolley car* should be heard as creative too. Clearly, something has gone wrong. (Fodor and Lepore 1998:12)

A third piece of evidence is the capacity of a lexical semantic theory to state conditions on semantic wellformedness. Again, it is doubtful whether the lexicon should have that power. F&L call into question the very existence of wellformedness conditions “distinct from ungrammaticality, necessary falsity, and any of a variety of kinds of pragmatic malfeasance” (Fodor and Lepore 1998:275). All such conditions efficiently apply in domains other than the lexicon. The null hypothesis would thus appear to be the attribution of a given illformedness to syntax, semantics or pragmatics. Since the primary function of the lexicon is stipulating the atoms of linguistic operations, and systems of linguistic operations exist outside the lexicon, the very concept of lexical-semantic wellformedness is questionable.

In conclusion, neither inter-lexical relations, nor ambiguity or semantic wellformedness call for recursive mechanisms in the lexicon. I therefore follow F&L and conclude that the lexicon is an arbitrary list.

F&L endorse a forth argument that is very closely related to our *properties problem* above. In this argument, F&L try to refute the claim that the semantic properties of a lexical item determine (some of) its syntactic properties. The argument is based on the difficulty to formalize “the semantic end of the putative semantics/syntax correlations [...] with sufficient clarity to permit the claims to be evaluated” (Fodor and Lepore 1998:276).

Notice that this kind of reasoning is substantially different from the arguments presented above. Instead of calling into question the desirability of a theoretical goal, it simply states the difficulty of getting there. What is more, F&L capitalize on the notoriously vague notions of *affectedness*, and the *boundedness* of events in their argument (cf. section 1.2.2). Surely, the

absence of an adequate theory on how lexical knowledge is represented in syntactic structure at this moment in history does not imply that such a theory could not, eventually, exist. Far from refuting lexical semantics, F&L have identified its object of inquiry.

In the following sections, we will turn to a modular analysis of central thought processes, trying to extract an answer to the *properties problem*, which is compatible with the conclusion that the lexicon is a list.

3.2. Domain specific thought: ToBy, ToMM, and agency

A strong version of the modular hypothesis holds that even central, conceptual processes are domain-specific operations. Fodor (1987:27) disqualifies such an assumption as “modularity theory gone mad”. Nevertheless, a substantial field of research has since grown, producing significant insights, especially for the development of cognitive mechanisms from infancy onwards.

An implementation of this hypothesis is the *theory* theory that considers “everyday knowledge as falling into folk or commonsense theories” (Hirschfeld and Gelman 1994:12). A commonsense theory can be viewed as a set of beliefs that allows an individual to interpret and explain the behavior of an object of a given domain, as well as predict its future behavior (Gopnik and Wellmann 1994).

Specified knowledge systems of this kind presuppose mechanisms that allow a categorization of objects into domains, a system of *domain-specific perception*. Once an object is categorized as belonging to a particular domain, its future behavior can be predicted in line with the principles governing that domain.

The perception and interpretation of events appears to depend on two major systems of cognition. One of them is responsible for the individuation of physical objects as distinct from others, with their mechanical properties, and with the prediction of their behavior in three-dimensional space. Another system is responsible for the recognition of volitional agents as opposed to dead objects. In addition to movement and interaction in three-dimensional space, volitional agents are capable of internalized, mental behavior and interaction at a distance. The latter system is responsible for the prediction of such behavior.

3.2.1. *Physical objects and ToBy*

According to Carey and Spelke (1994), physical objects are perceived “in accordance with the principles of cohesion, contact, and continuity” (p.175). The principle of *cohesion* predicts that an object maintains its integrity under movement. As a consequence of this principle, two adjacent objects lacking clear boundaries are perceived as one object if they appear stationary, but they are perceived as two distinct objects, if there is movement of one with respect to the other. The principle of *contact* predicts that objects move together only if they are in contact. Reaction at a distance is not interpreted as a property of physical (inanimate) objects. *Continuity* finally predicts that an object moves on exactly one, continuous path. If an object vanishes, and then reappears in a different position, moving in a different direction, the two occurrences are perceived as distinct objects.

Once a physical object has been individuated as a single entity, its central property is inertia. When it moves, it is predicted to continue moving on its path, and when it is stationary, it is predicted to stay where it is. However, physical objects can be pushed or pulled by other physical objects, and individuals can predict the resulting movements. Leslie (1994) argues that there is a cognitive domain responsible for just that. A *Theory of Body mechanism* (ToBy) is

concerned with Agents in a mechanical sense [...]. Distinguishing agents from other physical bodies that are not Agents and describing their mechanical interactions are important functions of **ToBy** (Leslie 1994:122).

According to Leslie, human individuals have adapted to the physical world in which “object motions are invariably the result of energy distribution” (Leslie 1994:125) by ascribing *force* to objects:

ToBy is concerned with three-dimensional objects as the principal bearers, transmitters, and recipients of FORCE (Leslie 1994:126).

The concept of *force* is the psychological interpretation of physical energy, and although it is extremely shallow from a scientific point of view, it is useful as a psychological postulate, because it allows wide-spread commonsensical force-ascriptions, where physical energy is actually absent.

In sum, a commonsense theory of mechanical action (labeled *ToBy*) is responsible for the recognition of physical objects, and for the interpretation and prediction of their behavior in three-dimensional space, as caused by *force*. This notion corresponds to the one used in lexical semantics by Talmy (2000), Croft (1990, 1991, 1998) and others.

3.2.2. *Intentional agents and ToMM*

A commonsense theory of physics cannot predict the behavior of volitional agents. Predicting such behavior requires a *theory of mind* that specifies how (possibly counterfactual) representations of states of affairs are related to each other, and how such mental representations can trigger actions. In Leslie (1994), the folk theory of mind is called **ToMM** (Theory of Mind Mechanism).

The distinguishing property of living and sentient kinds is autonomous, goal-directed movement.² Goal-directed movement must be distinguished from superficially similar kinds of movement: being pushed (Montgomery 1996) or pulled (White and Milne 1997) towards a goal by another object:

[...] if Michael Jordan consistently hits his baskets, we would say that the movements of Michael Jordan were goal-directed, but we would not say that the movement of the basketball itself was goal-directed. Indeed, 3- and 5-year-olds reliably see the difference between being pushed toward a goal and moving there autonomously [...] (Opfer 2002:100)

White and Milne (1997) argue that an impression of pulling is decreased by a delay before movement, and a change in direction. Furthermore, goal-directed movement typically ends upon reaching the goal (*satisfaction*), and it is characterized by a *direct trajectory* towards the goal (Gergely et al. 1995; Premack and Premack 1997). When these factors are taken into account, then goal-directed motion consistently elicits animacy judgments in adults (Opfer 2002).

A subsequent question is of course whether goal-directed movement indicates merely life, or also sentience. In other words, is it a necessary condition of goal-directedness that the agent possesses a mental representation of the goal?

Indeed, this domain is subject to fundamental changes during development. Opfer and Gelman (2001) observe that children at age 10 and adults are capable of attributing goal-directed action to insentient plants. Like adults, 10 year-olds possess the relevant knowledge about biological objects, which allows them to make such judgments. By contrast, preschoolers do not. In explaining goal-directed action, they “referred to psychological states more often than any other factor” (Opfer 2002:103).

At an even earlier stage, when children do not yet ascribe psychological states to individuals, they can nevertheless identify and predict goal-direction motion. Gergely and colleagues (Csibra et al. 1999; Gergely et al. 1995; Gergely and Csibra 1997; cf. also Perner and Davies 1991; Perner

1995) argue that children as young as 12 months can interpret goal-directed movement as a rational means action. They do so by taking a *teleological stance*. “[W]hen interpreting behavior as goal-directed” at this stage, “rationality is attributed as a property of the *action*, and not of the agent (or the agent's mind).” (Gergely and Csibra 1997:233).

Developmentally, teleological interpretations are transformed into causal mentalistic ones by 'mentalizing' the explanatory constructs of the teleological stance: i.e., by turning representations of actual reality constraints into 'beliefs' (which mentally represent such constraints), and representations of future goal states of reality into 'desires' (which mentally represent goal-states) (Gergely and Csibra 1997:232).

As Opfer and Gelman (2001) have shown, this *mentalization* is fully developed in preschoolers at the age of 5 years, who predict autonomous goal-directed motion with reference to mental states like beliefs and desires. The developmentally later distinction between non-sentient plants and sentient animals/humans only restricts the set of volitional agents in response to growing knowledge of the biological world. Such developments no longer affect the way in which volitional action is identified, interpreted and predicted.

The central explanatory construct employed by the adult folk-theory of mind is what the philosophical literature knows by the name of a *propositional attitude* (Frege 1879, 1892; Schiffer 1987). Like *force* in the domain of mechanical interaction, a *propositional attitude* is a relation between an agent and an object. In contrast to *force*, the agent of a propositional attitude must be sentient, and its object can be fictional, or far removed in space and time. Most importantly, the object of a propositional attitude may have the power to teleologically cause mechanical action.

3.3. Crossing the interface: cognition, syntax, and the lexicon

Turning back to the representation of verb meanings, recall the conclusion of Fodor and Lepore (1998) that recursive mechanisms in the lexicon are both redundant and undesirable. On the assumption of domain specificity in the central system, the situation becomes even worse for event composition in the lexicon. There are highly specialized subsystems of the mind, which are responsible for the computation of event representation. Concep-

tual parsimony dictates that such mechanisms should not be duplicated in the lexicon.

What the lexicon does need to encode is the information necessary for the central system to interpret the meaning of a verb, and it must do so in a way that is legible to the computational system. In this sense, the lexicon is indeed an interface. The question is now whether the complexity of representation we find at both sides of the lexicon, in the central systems of thought, and in the computational system of language, is sufficiently similar in order to justify the hypothesis of a structure preserving mapping from the mind into language. This question has been at the core of linguistic theorizing for a long time, and indeed there is mounting evidence to the effect that the mechanisms involved in the generation of linguistic complexity are fundamentally different from those involved in thought.

First, linguistic competence and general intelligence are functionally dissociated. Various forms of *specific language impairment* (Wexler 2003), both in acquisition and loss of linguistic competence, can occur without repercussions for the central system of thought. On the other hand, linguistic competence can be fully developed in spite of a severe cognitive impairment, as in *Williams syndrome* (Pinker 1999).

Second, linguistic expressions exhibit a number of peculiarities we do not find outside the language faculty. Chomsky (2001) recently calls such peculiarities *imperfections*, because they cannot be reduced to general cognitive or biological mechanisms. One of these is the *displacement* property. Constituents of a linguistic expression often appear in a position we would not expect, if language were a direct expression of thought. This second aspect, one of the cornerstones of the universalist hypothesis, is particularly relevant for the present discussion, and what we have called the *mapping problem* above. Recall from section 2 that theories on the mapping from lexical semantic structure into syntax face a severe problem. The problem was that lexicon-syntax relations cannot be formalized as a morphism: they are *many-to-many*.

On the assumption of a modular theory of the mind, such arbitrariness is expected. If the language faculty is a module, it operates encapsulated and blind. If we were to find a morphic mapping from event representation (i.e., cognition) into syntactic structure, such a finding would seriously challenge the encapsulated status of the language faculty, and support a more holistic view. As a matter of fact, it turned out throughout section 1 above that the relation between event representation (i.e., cognition) and syntax is notoriously vague. While some core notions like *agent* and *af-*

affected object tend to have regular realizations in grammar, the more complex an event representation becomes, the less likely it is that we find all event participants realized in a canonical grammatical environment, or that they are realized at all. Furthermore, the picture is blurred by the possible interaction of distinct sub-systems of cognition in the computation of a given event, especially when it comes to psychological predicates. If there is a morphic mapping from cognition into syntax, which module of cognition should take precedence over the other?

None of these problems arises if we assume that the lexicon is a list. When we speak of a verb as naming a section in the representation of an event in this sense, we can only mean that the lexical entry of the verb classifies its arguments as agents and patients with respect to the respective sub-system of cognition. Rather than representing complex event structures, a listed lexicon makes reference to a finite set of analyzable thematic roles. Consider as an illustration the contrast between *fear* and *frighten*:

- (29) a. *John feared Helen/a renewed outbreak of cholera.*
 b. *Helen/The renewed outbreak of cholera frightened John.*

Both verbs clearly name a psychological event. In the case of *fear*, the subject exhibits cognitive activity. It is therefore an agent for ToMM. The object, even if it denotes a sentient individual, corresponds to the content of the emotion. Therefore, it is a patient for ToMM. As far as the physical world is concerned, the verb *fear* does not constrain interpretation of its object (cf. the distinction between *cause* and *subject matter of emotion* in Pesetsky (1995)).

The verb *frighten* behaves differently. Here it is the object, not the subject, which refers to a sentient, mentally active individual, i.e., an agent for ToMM. At the same time, the object of *frighten* is understood as the target of an external agent (the cause of its emotion). This state of affairs is accounted for, if *frighten* selects one argument (the subject), which is an agent for ToBy, and underspecified for ToMM, and another argument (the direct object), which is both an agent for ToMM and a patient for ToBy.

Specifications of this sort do not require lexical semantic *structure*. They can be spelled out as a simple list of features associated with any given lexical entry. A proposal along these lines has been made by Reinhart (2000), who argues that thematic information should be modeled in the form of feature clusters. Each cluster describes properties of one event participant. Although Reinhart (2000) motivates her features from a

completely different perspective, the structure of narrative discourse (Miller and Johnson-Laird 1976; Rumelhart 1975; Shen 1985), they are ideal for the present purpose, because they refer to the domains of physical and mental activity, respectively. The feature referring to mental activity is called *m*, the one referring to physical activity is called *c*.

Coming back to the examples in (29), we may want to say that the lexical entry of *fear* incorporates two feature clusters (or Θ -roles). The cluster assigned to the direct object is specified as $[-m]$, because the object must be the content of an emotion, and it is underspecified with respect to the physical domain. The cluster assigned to the subject is specified as $[\alpha c +m]$, because the subject of *fear* must engage in a mental activity. Whether this cluster is specified for the feature *c* is irrelevant for the present purpose of illustration.

(30) *fear*: $\{[\alpha c +m], [-m], \dots\}$

Likewise, the lexical entry of *frighten* must make reference to an argument, which is both an agent for ToMM, and a target of *force*. These properties are encoded as $[-c+m]$. In addition, *frighten* requires an argument that is an agent for ToBy, but underspecified with respect to the mental domain, which is encoded as $[+c]$. This gives us the following partial entry for *frighten*:

(31) *frighten*: $\{[+c], [-c+m], \dots\}$

4. Reinhart's feature theory

There is no syntactic structure in the lexicon; this would be a superfluous reduplication of the syntactic component. [...] Furthermore, we believe that lexical arity operations apply to the verb entry itself, which is a collection of properties/features, and not to an abstract event semantics representation (e.g., $\lambda y \lambda x \lambda e (\text{wash}(e) \ \& \ \text{Agent}(e, x) \ \& \ \text{Theme}(e, y))$). More specifically, we assume that the event semantics representation is associated with the verb only during the derivation, and it is built compositionally on the basis of syntactic structure (Reinhart and Siloni 2005:12).

The following section is a brief sketch of the most important assumptions, exemplified with mostly English data.

4.1. The lexicon uniformity principle

At the basis of Reinhart (2000), we find a principle of economy, the *Lexicon Uniformity Principle*. This principle substantiates the status of the lexicon as a kind of “bottle-neck” between the domains of cognition and grammar.

(32) Lexicon Uniformity Principle (Reinhart 2000:4)

Each verb-concept corresponds to one lexical entry with one thematic structure. → The various thematic forms of a given verb are derived by lexicon-operations from one thematic structure.

In line with the Lexicon Uniformity Principle, Reinhart assumes that lexical entries encode the sum of information that can be realized in different diatheses. Correspondingly, the syntactic realization of a verb is often less complex thematically than its lexical representation would allow it to be. In this respect, Reinhart's approach differs from many others, e.g., Kratzer (1996), Pesetsky (1995), who assume argument-roles can be introduced in syntax, by means of adding an appropriate head. In Reinhart (2000), complex thematic configurations can be created in syntax, but they require the merger of distinct lexical items. A single lexical item cannot be causativized in syntax.

Therefore, if one diathesis of a verb indicates the presence of a given thematic feature-cluster, then it is assumed that this cluster is part of the verb's lexical entry. If this very role is absent in another diathesis, Reinhart assumes with Chierchia (1989) it has been eliminated by one of a small set of lexicon-operations, to which we turn in section 4.5.

Take as an example the contrast between causative and inchoative *melt*:

- (33) a. *The sun melted the ice-cube.*
 b. *The ice-cube melted.*

On Reinhart's assumptions, the causative use of the verb represents the basic lexical entry: both the cause ([+c]), and the theme-role ([-c-m]) are assigned to an argument. The inchoative use of *melt* in (33b) is derived from its lexical representation by a reduction-operation that eliminates [+c] (sect. 4.5).

4.2. Notational conventions

If we want to state generalizations for natural classes of thematic roles, we need notational conventions to refer to specific features. Reinhart (2001:3) adopts the following conventions:

(34) Notation (Reinhart 2001:3)

$[\alpha]$ = Feature cluster α .

$/\alpha$ = Feature (and value) α . (E.g. the feature $/+m$ occurs in the clusters $[+c+m]$, $[-c+m]$ and $[+m]$)

$[/\alpha]$ = A cluster one of whose features is $/\alpha$. (E.g. $[-c]$ clusters are $[-c+m]$, $[-c-m]$ and $[-c]$.)

$[+]$ = A cluster ALL of whose features have the value $+$. (E.g. $[-]$ clusters are $[-c-m]$, $[-c]$, $[-m]$.)

These conventions are adopted here without modification. We might want to add the possibility to refer to a feature irrespectively of its value:

(35) α = Feature α . (E.g. the feature m designates an argument for interpretation in *folk psychology* (ToMM))

4.3. Feature clusters and verb classes

The two binary features c and m define natural classes of verbs that often cut across the correspondence classes defined by traditional listed roles, or those that follow from specific assumptions about basic predicates in event decomposition frameworks. For example, Reinhart's notation allows the statement of generalizations affecting agents, causes, emitters (i.e., *immediate causes* in Levin and Rappaport Hovav (1995): all of these roles are $[/+c]$ clusters. They differ with respect to the presence and value of m . Agents are specified as $[+c+m]$, causes as $[+c]$, and emitters (like instruments and some others) are specified as $[+c-m]$. Likewise, the notation allows generalizations over agents and experiencers. Both are $[/+m]$ roles. Agents are specified as $[+c+m]$, experiencers as $[-c+m]$. A third possibility, underspecified $[+m]$, is mentioned, but not discussed in Reinhart's work. It will become important from chapter 2 onwards.

Generalizations of this sort are exemplified in the following subsections, with examples from Reinhart (2001).

4.3.1. *Underspecified causes: [+c]*

An underspecified [+c] cluster is compatible with agents, causes and instruments. It is postulated for verbs allowing a range of subjects, like the following:

- (36) V([+c], [-c-m]) – *break, open, roll...*
 a. *The wind/Max/the key opened the door.*
 b. *The storm/Max/the stone broke the window.*
 c. *The earthquake/Max the stick rolled the stone.*
- (37) V ([+c], [-c+m]) – *worry, amuse, scare, surprise...*
 a. *Max/the noise/the gun scared Lucie.*
 b. *Fred/Fred's behavior/the discussion surprised Lucie.*

A typical property of the theme-object verbs in (36) is that they tend to alternate with unaccusatives, while the experiencer-object verbs in (37) tend to alternate with unergatives (38a) or reflexives (38b) in many languages, like for instance German (38b).

- (38) a. *Max worries.*
 b. *Max wundert sich.*
 Max surprises refl.
 'Max is surprised.'

We can formulate these observations in terms of feature specifications:

- Underspecified [+c] can be reduced.
- The resulting intransitive is realized as an unaccusative, if it selects [-c-m].
- The resulting intransitive is realized as an unergative or reflexive, if it selects [+m].

4.3.2. *Agents: [+c+m]*

Fully specified [+c+m] is postulated, if the subject selected by a verb must be an agent in volitional control over the event:

- (39) V ([+c+m], [-c-m]/[-c+m]) - *eat, shave, dress...*
 a. *The baby/ *the spoon/ *hunger ate the soup.*
 b. *Lucie/ *The razor/ *the heat shaved Max.*
 c. *Lucie/ *the snow/ *the desire to feel warm dressed Max.*
 d. *Max shaved/dressed.*

Members of the agent-subject class tend to have reflexive (39d), but no unaccusative alternate. Reinhart (2000) generalizes from this (and other) facts that a [+m] cluster cannot be reduced.

4.3.3. *Manner verbs and indirect causation: [/+c], [+c-m]*

An interesting class of verbs allows either a volitional agent, or an instrument, but excludes a cause in subject position (40a/b vs. c). Reinhart (2001) refers to the verbs in this class as *manner verbs*, because they specify a specific way in which an agent performs an action. This property is represented by the selection of two [/+c] clusters. When the agent is realized in subject position, the [+c-m] cluster can be realized as an instrumental PP (40a). The instrument may also be realized in subject position. In that case, the agent cannot be realized at all (40b).

- (40) a. *Max peeled the apple (with the knife).*
 b. *The knife peeled the apple.*
 c. **The heat peeled the apple.*

- (41) *drill/peel* ([+c+m], [-c-m], [+c-m])

A comparable class of verbs is discussed in Grimshaw (1990) and Rapp (1997): *verbs of indirect causation*. Verbs of this kind name events that are typically composed of two sub-events: an activity and a resultant state. Unlike the event decomposition framework employed by Rapp (1997), Reinhart's notation does not require a lexical stipulation of the fact that the mediating activity must be identical with the cause of the resultant state. It is merely encoded in the form of a [+c-m] cluster. By /-m, it is an object of the agent's intention, and by /+c, it physically acts upon the argument specified as /-c.

Like *manner verbs*, *verbs of indirect causation* have two transitive alternants, an agentive and an instrumental one:

- (42) a. *Hans enttäuschte uns mit seiner Leistung.*
 Hans disappointed us with his performance
 b. *Seine Leistung enttäuschte uns.*
 his performance disappointed us

We can generalize that alternations of this sort occur whenever a verb selects two $[/+c]$ clusters. Other example verb classes are cause-substance verbs like *fill* (notice that *fill* selects $[+c]$ rather than $[+c+m]$, and that German *füllen* behaves differently):

- (43) a) *Max/ the hose/ the storm filled the pool with water.*
 b) *The water filled the pool.*

- (44) *fill* ($[+c]$, $[-c-m]$, $[+c-m]$)

In line with the generalization that $[+c]$ can be reduced, verbs like *fill* have unaccusative alternants:

- (45) *The pool filled (with water).*

4.4. The realization of thematic feature clusters

The thematic feature specifications associated with a given verb determine the merging order of its arguments. This is accomplished by two interacting mechanisms.

First, a marking procedure designates thematic features for internal and external realization, respectively. In addition to this indexation, some verbs are marked with a subcategorization feature, accusative case. Verbs that are marked in this way must merge an argument DP in the position of a direct object.

In a second step, merging instructions guide the introduction of NP-arguments in accordance with the thematic features they are to realize.

4.4.1. Marking

The marking procedure is intended to serve several functions in Reinhart's work. First, it introduces a fundamental distinction between transitive and intransitive verbs. Only transitive verbs are marked, intransitives are left unmarked.

Second, the marking procedure distinguishes three classes of thematic role clusters: [+] clusters are marked with index 1, [-] clusters are marked with index 2. The mixed value clusters remain unmarked, as does the single cluster selected by underlyingly monadic verbs.

Finally, the marking procedure assigns an accusative subcategorization feature to prototypical transitives, which select both a [+] cluster, and a fully specified [/c] cluster.

(46) Lexicon marking (Reinhart 2001:16)

Given an n-place verb-entry, $n > 1$,

- a. Mark a [-] cluster with index 2.
- b. Mark a [+] cluster with index 1.
- c. If the entry includes both a [+] cluster and a fully specified cluster [/α,/-c], mark the verb with the ACC feature.

(46) effectively derives much of the predictions Talmy (2000), Croft (1991, 1998) arrive at on the basis of their force-dynamic theory. The most important departure from Croft's proposal is the distinction between mental and physical activity. The effect of this distinction is that psychological verbs are no longer exceptional, and no separate system of verb-frames is needed to account for them. Their behavior is fully expected on the basis of the mixed value specification of experiencers, and their interaction with other clusters at the moment they are realized in a syntactic derivation.

4.4.2. Merging

Reinhart's *merging instructions* distinguish three scenarios. (i) The assignment of marked clusters is governed by their index (47b). (ii) If no cluster is marked with index 1, then the default rule (47a) applies. (iii) In the presence of two unmarked clusters, their realization is free.³

- (47) CS merging instructions (Reinhart 2001:16)
- When nothing rules this out, merge externally.
 - An argument realizing a cluster marked 2 merges internally; an argument with a cluster marked 1 merges externally.

This system derives the prototypical transitive sentence as one with two marked clusters assigned, a [+] cluster in external position, and fully specified [-c] cluster in internal position.

The system also derives unergatives as prototypical intransitives. This follows from the default merging rule (47a), and the exemption of genuinely monadic verbs from the marking procedure (46).

Most unaccusatives, and reflexives are analyzed as derived forms.

4.5. Arity operations and the like

There are two major classes of verbs that show a systematic alternation between transitive and intransitive uses cross-linguistically: unaccusatives and reflexives. Several authors take the intransitive use as basic, and derive the transitive variant with the help of a transitivizing syntactic head (Kratzer 1996; Pesetsky 1995).

In Reinhart's framework (cf. also Chierchia 1989), the transitive entries are basic, and the intransitive ones are derived. An operation of reduction derives intransitive from marked transitive entries.

Reduction can apply to an internal, or to an external cluster. Consequently, Reinhart distinguishes between internal and external role reduction: *expletivization* deletes an external cluster; *reflexivization* an internal cluster with an external one.

Turn first to external role reduction, the one that derives unaccusatives. This kind of operation targets only transitive entries with a [+c] external cluster. It deletes the external Θ -role and the ACC feature of the verb. If the remaining cluster is marked 2 (i.e., [-c-m], [-c], or [-m]), it must be realized internally, and the result is an unaccusative verb, as in (49).

- (48) Decausativization: Reduction of an external [+c] role ((67a) in Reinhart and Sioni 2005)

$$V_{acc} (\Theta_1 [+c], \Theta_2) \rightarrow V (\Theta_2)$$

- (49) *open*_{ACC} ([+c], [-c-m]) \rightarrow *open* ([-c-m])

On the other hand, if the remaining cluster is not marked, it must be realized externally by the default rule (47a). This is most notably the case with psychological predicates like *worry* in (50).

- (50) $worry_{ACC} ([+c], [-c+m] \rightarrow worry [-c+m])$

A second major operation bundles an internal and an external role and forms a single, conjoined role cluster. Reflexivization eliminates the ACC feature in some, but not in all languages.

- (51) Reflexivization ((24) in Reinhart and Siloni 2005)
 $[\Theta_i] [\Theta_j] \rightarrow [\Theta_i - \Theta_j]$, where Θ_i is an external role

- (52) *Max shaved.*

Third, saturation can apply to implicit arguments. Saturation is typically involved in the derivation of passives and middles (Marelj 2004).

- (53) a. *wash* (Θ_1, Θ_2)
 b. Saturation: $\exists x (wash(x, \Theta_2))$
 c. *Max was washed* $t \equiv \exists x (x washed Max)$.

There is one more lexicon operation in Reinhart's system: *causativization*. Rather than eliminating or saturating a role cluster, causativization manipulates the feature specification of existing roles, and adds an agent cluster.

- (54) a. *John walked.*
 b. *John walked the dog.*

- (55) Causativization ((21) in Reinhart 2002)
 a. *Decausativize*: Change a $/+c$ feature to a $/-c$ feature.
 $walk([+c+m]) \rightarrow walk([-c+m])$
 b. *Agentivize*: Add an agent role.
 $walk([-c+m]) \rightarrow walk([+c+m], [-c+m])$

Causativization is necessary, because the alternation it describes affects a $/+m$ cluster, and $/+m$ cannot be eliminated by hypothesis.

The only thing that can happen to a lexical $[/+m]$ cluster is to remain unrealized, as it is the case in the alternation described for *manner verbs* and *verbs of indirect causation* above:

- (56) a. *Max peeled the apple (with the knife).*
 b. *The knife peeled the apple.*
 c. **The heat peeled the apple.*

- (57) *drill/peel* ($[+c+m]$, $[-c-m]$, $[+c-m]$)

Remaining unrealized is an option not only for *manner verbs*. It is made use of in the context of the *subject matter* problem (Pesetsky 1995; Reinhart 2002). Consider the following paradigm:

- (58) a. *The article angered Bill.*
 b. *The government angered Bill.*
 c. **The article angered Bill at the government.*
 (59) *The article made Bill angry at the government.*

Pesetsky (1995) shows that verbs like *anger* select two cause-like thematic roles, a *cause* ($[+c]$ in the present notation), and a *target/subject matter of emotion* ($[-m]$ here):

- (60) *anger* $[+c]$, $[-c+m]$, $[-m]$

Although they are logically compatible as shown in (59), the two roles cannot co-occur in a single predicate (58c). Reinhart (2001) argues that this observation must be blamed on a condition of cluster distinctness:

- (61) Cluster distinctness (Reinhart 2001:14)
 a) Two indistinct Θ -clusters cannot be both realized on the same predicate.
 b) Distinctness: Two feature-clusters α , β are distinct iff a. they share at least one feature, and b. there is at least one feature or value which they do not share.

Since $[+c]$ and $[-m]$ do not share a feature by which they could be distinguished, one of them must remain unrealized.

5. Conclusion

This chapter undertook to delimit the demands on a theory of lexical semantics, stating three questions: a *properties problem*, an *interface problem*, and a *mapping problem*. After a brief summary of the literature, it was argued that the theoretical status of lexical semantics must be determined by explicit assumptions about adjacent domains of the mind, namely cognition and language. With respect to cognition, a modular theory of central thought processes was adopted. It was claimed that two modules are of primary importance for the interpretation of events, a *commonsense theory of physics*, and a *commonsense theory of mind mechanisms*. Since these modules are powerful enough to create complex event representations, complexity in lexical representation was rejected as unnecessary. It was argued, however, that lexical verb meanings should encode information about (i) domain-specific categorization, and (ii) agentive status of its arguments. This was the answer to the *properties problem*.

The feature notation in Reinhart's *Theta System* was found to match these demands in an ideal way, and it was therefore adopted. Reinhart's notation supplies a trivial answer to the *interface problem*. Binary features are legible by the computational system, and they can easily be interpreted as neo-Davidsonian predicates in the semantic component.

The stage has now been set to investigate the most interesting question of lexical semantics, the *mapping problem*. In chapter 2, the (lexical and syntactic) argument structure of a set of German verbs will be described in some detail. Chapter 3 then develops a theory of syntactic projection that accommodates both the facts of chapter 2, and the conceptual demands argued for in this chapter: a listed lexicon, and an autonomous syntax.

Notes

- ¹ Notice that this is not the case for formulations in terms of thematic positions and visibility, rather than discrete roles, as in Chomsky (1986:97): “*Each argument A appears in a chain containing a unique visible theta position P, and each theta position P is visible in a chain containing a unique argument A.*”
- ² “*Movement* is used here in the full sense used by Michotte (1963), which includes ‘changes in shape’, which he classifies as the special movement of the ‘kinaesthetic amoeba’ (pp.204-206). Thus, a plant growing toward the sun, or an amoeba engulfing a paramecium would equally count as movements” (Opfer 2002:100).
- ³ Notice that this formulation of the merging instructions predicts that a verb selecting two mixed-value clusters should have variable argument realization. A case at hand would be the German verb *faszinieren* (to impress). It will be argued in chapter 2 that this is not true. [+c-m] cannot be assigned to an internal argument.