Lexical Shadowing and Argument Closure

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Abstract

In this paper, I discuss the issues of compositionality and polysemy as they relate to current accounts of verbal alternations in linguistic theory. I first explore generally how alternations can be seen as emerging from a semantic theory that takes advantage of lexical underspecification and generative mechanisms of composition. Such well-studied alternations such as causative-inchoative and control-raising pairs can be successfully analyzed as resulting from the interaction of richer modes of composition and a semantics admitting of underspecified representations. I then examine a particular alternation involving verbs such as *risk* and *cost*, as well as cognate object verbs such as *dance* and *butter*. I refer to this alternation as *lexical shadowing*. This alternation is interesting because it cuts across the traditional categories as presented in Levin (1993). I discuss the current major analyses of such verbs, and show that these solutions fail to capture the lexical polymorphism in the alternation, and are only weakly compositional at best. I show how the complement behavior of verbs such as *risk* involves coercion on an underspecified lexical semantic representation. I close with a discussion of the selectional properties of complex relations such as *read* and *rent*, and how this impacts the theory of closure.

1 Introduction

In this paper, I address the general nature of argumenthood and what logical distinction is possible between argument types. In particular, I examine the syntactic and semantic behavior of verbs such as *risk* and *cost*, and cognate object verbs such as *dance* and butter. Such verbs participate in an interesting alternation that I will refer to as *lexical shadowing*. Shadowing can be defined as the relation between an argument and the underlying semantic expression which blocks its syntactic projection in the syntax. Informally, we see shadowing at work with the sentences in (1) and (2) below, where normally *cognate objects* are shadowed because of the semantics of the verb.

(1) a. Mary buttered her bread.
b. Mary buttered her bread with an expensive butter from Wisconsin.
c. *Mary buttered her bread with butter.

(2) a. Mary elbowed her partner.
b. Mary elbowed her partner with her arthritic elbow.
c. *Mary elbowed her partner with her elbow.

(3) a. John and Mary danced.
b. John and Mary danced a fast waltz.
c. *John and Mary danced a dance.

These well-studied alternations are related by the fact that the grammatical expression of a particular argument NP (in (1b), (2b), and (3b)) is licensed only when the NP stands in a subtype relation with certain "implicit semantic content" of the verb. That is, the underlying semantics of the verb *butter*, for example, shadows the expression of the material which is spread, and obviates its direct expression as an argument. However, when a specialization of this shadow argument is made, the shadow is "lifted" and grammatical expression of this information as an argument is possible. Similarly, with *dance*, the expression of an object is shadowed by the underlying semantics of the verb. Anything adding new information, however, will license the expression of an argument, and in particular, as a cognate object.

Normally, such behavior is thought to be confined to the verbal classes defined by this very alternation. But in fact, the process of shadowing shows up in classes completely unrelated to cognate object alternations. Observe, for example, that a similar kind of shadowing occurs with the verbs *build* and *carve* below:

(4) a. John built a house out of bricks.
b. John built a brick house out of limestone bricks.

(5) a. Mary carved a doll out of wood.
b. Mary carved a wooden doll out of pine.

The interaction here is more subtle, since the material which is incorporated into the direct object acts to shadow the expression of the (optional) material argument itself. It is likewise expressible only by subtyping, just as we saw with the cognate object verbs in (1) and (2).

There is a third type of lexical shadowing we will consider, where the expression of one argument completely shadows the expression of another argument to the verb, in a strictly complementary fashion. Such examples, studied in Fillmore and Atkins (1990), involve verbs such as *risk* and are illustrated in (5)-(7) below:

(6) a. Mary risked death to save her son.
b. Mary risked her life to save her son.

(7) a. Mary risked illness.
b. Mary risked her health.

(8) a. John risked bankruptcy doing that.
b. John risked his own solvency doing that.

What is interesting about about these examples is that the direct object in each (a) sentence stands in complementary distribution to those in the (b) sentence, yet they are semantically near paraphrases of each other. Whatever the thematic or case structure of the verb is, it is clear that the presence of one argument acts to completely shadow the expression of the other.

Finally, there is a fourth type of shadowing which is not purely lexical, but is the result of compositional operations in the syntax. Consider the way in which a normally obligatory argument to the three-place predicates *give* and *mail* is shadowed in the (b) sentences, but not in the ungrammatical (c) sentences.

(9) a. John gave a talk to the academy today.
b. John gave a talk today.
c. *John gave a book today.

(10) a. Mary mailed a letter to me.
b. Mary mailed a letter.
c. *Mary mailed a book.

In these examples, it is the specific semantics of the complements *talk* and *letter*, respectively, which obviate the obligatory expression of the indirect object.

From the above discussion, we can thus identify the following four types of lexical shadowing:

1. Argument Shadowing: Expression of an argument is shadowed by:
   i. the verbal semantics directly, as in the cognate constructions; or
   ii. the semantics of the phrase, as with the *build*-examples.
2. Complementary Shadowing: Expression of one argument shadows the expression of another in a complementary fashion, as in the *risk*-examples.
3. Co-compositional Shadowing: Expression of an argument is made optional by virtue of how the verb interacts with its complement, as with the *give a lecture* cases.

In what follows, I will outline how shadowing is performed by the grammar, and in particular, I will look in some detail at cases of argument and complementary shadowing phenomena. I will then briefly discuss how co-composition operates to license the shadowing of obligatory arguments for verbs like *give* and *mail*.

2 Arguments and Closure

I will assume some general familiarity with the framework of a generative lexicon (GL), as outlined in Pustejovsky (1991, 1995), and Pustejovsky and Boguraev (1993). I will, nevertheless, review some of the basic assumptions of the theory and how they bear on the issues at hand. It is useful at this point, to make a comparison between the move in syntax towards explanatory models of description and the goals of generative lexicon theory (henceforth GL). The goals and results of the former have produced a methodology, within which abstract entities serve as tools toward generalization and explanation. For example, the theory of movement, however construed or formulated, postulates the existence of empty categories or their formal equivalent. With such entities comes the need to provide closure on their distribution. This has been at the core of generative syntax since the late 1960s. What has emerged is a variety of interpretations of how the "movement" phenomena should be accounted for theoretically.

For the purpose of the discussion below, a generative lexicon can be characterized as a system involving at least four basic levels of linguistic representation:

1. **Argument Structure**: Specification of number and type of logical arguments.
2. **Event Structure**: Definition of the event type of an expression and its subeventual structure.
3. **Qualia Structure**: A structural differentiation of the predicative force for a lexical item.
4. **Lexical Inheritance Structure**: Identification of how a lexical structure is related to other structures in the type lattice.

A set of generative devices connects these four levels, providing for the compositional interpretation of words in context (cf. Pustejovsky, 1995). The exact nature of these devices determines the polymorphic expressiveness of the semantics in fairly restrictive ways. These devices include *type coercion*, *subselection*, and *co-composition*. Our interest in this paper is to explain the polymorphic behavior of verbs which allow lexical shadowing of their arguments. This is important both for syntactic and semantic considerations, since such alternations are not idiosyncratic, but are in fact systematic in nature. In the discussion below, we begin with the nature of verbal semantics and how argument types determine syntactic behavior.

Following the discussion given in Pustejovsky (1995), I will assume that the semantics of a lexical item α can be defined as a structure, consisting of the following four components:

(11) $\alpha = <\mathcal{A},\mathcal{E},\mathcal{Q},\mathcal{I}>$

where $\mathcal{A}$ is the argument structure, $\mathcal{E}$ is the specification of the event type, $\mathcal{Q}$ provides the binding of these two parameters in the qualia structure, and $\mathcal{I}$ is an embedding transformation, placing α within a type lattice, determining what information is inheritable from the global lexical structure. I will assume further that verbal semantics encodes reference to both event and subevent variables, and that the predicative force of a verb is systematically structured within a representation factoring aspects of the predicate into distinct modes of explanation, or *qualia*. Hence, rather than a conventional Davidsonian-like representation for a verb such as *build*, shown in (12),

(12) $\lambda y \lambda x \lambda e[build(e,x,y) \wedge \theta_1(e,x) \wedge \theta_2(e,y)]$

I assume a richer lexical structure called *Orthogonal Parameter Binding* (cf. Pustejovsky, 1995a). In this system, the logical arguments of an expression are separated by type, where logical arguments are distinct from the event structure arguments defined for a particular lexical item. Given a listing of logical arguments and an event structure represented as a listing of event types,

(13) a. $[\text{ARGS} = \text{ARG}_1,\ \text{ARG}_2,\ \ldots,\ \text{ARG}_n]$
b. $[\text{EVENTSTR} = \text{EVENT}_1,\ \text{EVENT}_2,\ \ldots,\ \text{EVENT}_n]$

one can view the semantics of the verb as being centrally defined by the qualia, but constrained by type information from the orthogonal bindings of the two parameter lists. The predicates in the qualia refer directly to the parameters:

(14) $[\text{QUALIA} = [\ldots\ Q_i = \text{PRED}(\text{EVENT}_j, \text{ARG}_k, \text{ARG}_l)\ \ldots]]$

In Pustejovsky (1995a), a further distinction is introduced, distinguishing between four types of arguments:

1. TRUE ARGUMENTS: Syntactically realized parameters of the lexical item;

2. DEFAULT ARGUMENTS: Parameters which participate in the logical expressions in the qualia, but which are not necessarily expressed syntactically; e.g. "John built the house *with bricks*".

3. SHADOW ARGUMENTS: Logical parameters which are semantically incorporated into the lexical item. They can be expressed only by operations of subtyping; e.g. " Mary buttered her toast *with an expensive butter*."

4. OPTIONAL ARGUMENTS: Parameters which modify the logical expression, but are part of situational or propositional interpretation, not any particular lexical item's semantic representation. These include adjunct expressions of temporal or spatial modification.

The above classification attempts to refine the classification between argument and adjunct phrases. It is not just the lexical properties of a single item which determines the logical status of a phrase as a certain argument type. Compositional operations may create an argument or shadow an argument at a non-lexical projection, by virtue of compositionality in the phrase. In other cases, however, a logical argument is defaulted by virtue of a complement's semantic properties. For example, as discussed below, in the VP, *show a movie*, the goal argument is defaulted by the semantics of the complement, and becomes an optional argument (cf. Pustejovsky, 1992). Furthermore, default arguments when realized in certain ways, can mimic the behavior of shadow arguments. For example, in the sentence

(15) Mary built a wooden house with pine.

the default argument has effectively been saturated indirectly by a modifier in the direct object, and the further specification *with pine* is licensed in the same manner as in shadow arguments.

We can illustrate the nature of these distinct argument types in the argument structures for the verbs *build*, *butter*, and *kick*, as in (16)–(18), where D-ARG is a default argument, and S-ARG is a shadow argument.

$$(16)\quad \begin{bmatrix} \textbf{build} \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG}_1 = \textbf{animate\_individual} \\ \text{ARG}_2 = \textbf{artifact} \\ \text{D-ARG}_1 = \textbf{material} \end{bmatrix} \\ \ldots \end{bmatrix}$$

$$(17)\quad \begin{bmatrix} \textbf{butter} \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG}_1 = \textbf{human} \\ \text{ARG}_2 = \textbf{phys\_object} \\ \text{S-ARG}_1 = \textbf{butter} \end{bmatrix} \\ \ldots \end{bmatrix}$$

$$(18)\quad \begin{bmatrix} \textbf{kick} \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG}_1 = \textbf{animate\_individual} \\ \text{ARG}_2 = \textbf{phys\_object} \\ \text{S-ARG1} = \textbf{leg} \end{bmatrix} \\ \ldots \end{bmatrix}$$

I have yet to discuss the formal conditions under which these arguments are licensed or expressed, but what should be clear from this discussion is the usefulness of the logical distinction in argument types, both descriptively in terms of coverage of construction types, and theoretically in terms of the formulation of principles of mapping from lexical semantic forms.

A more detailed examination of the semantics of *build* reveals how the arguments interact in the relations specified by the qualia. Let us assume it denotes a transition between two subevents, a process of building followed by the existence of the object constructed. Furthermore, it has two arguments, with all the syntactic and semantic information entailed by that class (cf. Sanfilippo, 1993). In addition, there is a *default argument*, D-ARG, which participates in the relations of the qualia, but is not necessarily expressed in the syntax. This is the material or substance being used in the building process. The lexical representation for this verb is shown below, where I employ a feature structure notation to indicate argument and event types and how they are bound in the qualia structure.

(19)
$$\begin{bmatrix} \textbf{build} & \\ \text{EVENTSTR} = & \begin{bmatrix} \text{E}_1 = \textbf{process} \\ \text{E}_2 = \textbf{state} \\ \text{RESTR} = <_{\propto} \\ \text{HEAD} = \mathbf{e}_1 \end{bmatrix} \\ \text{ARGSTR} = & \begin{bmatrix} \text{ARG1} = \boxed{1} \begin{bmatrix} \textbf{animate\_ind} \end{bmatrix} \\ \text{ARG2} = \boxed{2} \begin{bmatrix} \textbf{artifact} \\ \text{CONST} = \boxed{3} \end{bmatrix} \\ \text{D-ARG1} = \boxed{3} \begin{bmatrix} \textbf{material} \end{bmatrix} \end{bmatrix} \\ \text{QUALIA} = & \begin{bmatrix} \textbf{create-lcp} \\ \text{FORM} = \textbf{exist}(\mathbf{e}_2, \boxed{2}) \\ \text{AGENTIVE} = \textbf{build\_act}(\mathbf{e}_1, \boxed{1}, \boxed{3}) \end{bmatrix} \end{bmatrix}$$

The initial building process is represented by the AGENTIVE event, involving both the syntactic subject, ARG1, and the default argument, D-ARG1, which gives rise to the event expressed in the FORMAL. This is the state of there being an individual, ARG2, defined as being made of the material from the default argument (cf. Pustejovsky, 1995b, for discussion).

As mentioned above, the type of the argument will affect how and whether it is realized in the syntax. For true arguments, the translation to conventional modes of typing is fairly straightforward, as the examples below illustrate.

(20) INTERPRETATION OF QUALIA STRUCTURE AS TYPES:
- a. Qualia Structure $\Longrightarrow$
- b. Type Structure $\Longrightarrow$
- c. Logical Form

(21) a. INTRANSITIVE VERB:

$$\begin{bmatrix} \alpha \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG1} = x \end{bmatrix} \\ \text{EVENTSTR} = \begin{bmatrix} \text{E1} = e_1 \end{bmatrix} \\ \text{QUALIA} = \begin{bmatrix} Q(e_1, x) \end{bmatrix} \end{bmatrix} \Longrightarrow$$

b. $e \rightarrow (e^\sigma \rightarrow t) \implies$
c. $\lambda x \lambda e_1 [Q(e_1, x)]$

For a verb such as *love*, with two arguments, a representation such as that in (22) would be necessary:

(22) a. TRANSITIVE VERB:

$$\begin{bmatrix} \alpha \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG1} = x \\ \text{ARG2} = y \end{bmatrix} \\ \text{EVENTSTR} = \begin{bmatrix} \text{E1} = e_1 \end{bmatrix} \\ \text{QUALIA} = \begin{bmatrix} \text{FORMAL} = R(e_2, x) \end{bmatrix} \end{bmatrix} \implies$$

b. $e \rightarrow (e \rightarrow (e^\sigma \rightarrow t)) \implies$
c. $\lambda y \lambda x \lambda e_1 [R_F(e_1, x, y)]$

Still, what is not explained, however, is how default and shadow arguments map into logical structures, the issue to which we turn directly.

The default arguments associated with relations such as *build* and *kick* as presented above are different in grammatical behavior from "pragmatically defaulting" arguments entering into polyvalency phenomena, as studied in the literature under object-drop and complement-deletion phenomena (cf. Bresnan, 1980, Fillmore, 1985, and surveyed in Levin, 1993).

(23) a. Mary ate dinner quickly.
b. Mary ate quickly.

(24) a. John tried to phone his mother yesterday.
b. John tried yesterday.

I will distinguish two types of argument closure. Both default arguments and shadow arguments, as discussed above, can be described as involving *lexical closure*, while polyvalency phenomena and pragmatically-controlled deletion can be seen as arising from *functional closure*. Syntactically, the distinction can be summarized as follows:

(25) a. LEXICAL CLOSURE: arguments are only expressible as oblique phrases to the predicate.
b. FUNCTIONAL CLOSURE: arguments are typically expressed as direct arguments to the predicate.

Semantically, the resulting interpretations may be the same or similar for both types of closure, but the consequences for compositional processes in the grammar are significant.

Let us now discuss the procedures for determining these two types of closure over default arguments. This will involve the following two assumptions:

1. Arguments introduced by lexical closure are treated as *specifications* to the variable;

2. Arguments introduced by functional closure are treated as true arguments.

The default arguments for verbs such as *build* and *arrive* can be represented as existentially quantified variables, present in the lexical structure of the predicate:

(26) a. $arrive \Longrightarrow \lambda x \lambda e \exists y{:}\texttt{loc}[arrive(e,x,y)]$
b. $build \Longrightarrow \lambda y \lambda x \lambda e \exists z{:}\texttt{material}[build(e,x,y,z)]$

The mechanism with which a lexically closed variable is able to be bound by a specification provided by an adjunct phrase can be stated as follows:

(27) ARGUMENT SPECIFICATION:
There is a function $\mathcal{F}$, such that $\mathcal{F}(\exists x{:}\sigma[\phi], \alpha) = \phi'$, where every occurrence of x is replaced by α, only if

i. the type of α is σ; this is *default argument* closure.

ii. the type of $\alpha \leq \sigma$; this is *shadow argument* closure.

As an example of this strategy, consider the sentence in (28), where a default argument is specified by the locative phrase *at the party.*

(28) a. John arrived at the party.
b. $\mathcal{F}(\lambda x \lambda e \exists y{:}\ \texttt{loc}[arrive(e,x,y)],$**at-the-party**$)$
c. Condition: Type(**at-the-party**) = $\texttt{loc}$
d. $\exists e[arrive(e, john, (\iota x{:}\ \texttt{loc})[party(x)])]$

Further examination of the conditions on how the default argument is bound to a possible expression in the syntax will not be addressed in this discussion. Suffice it to say, however, that specification of further properties of the variable is accomplished by oblique phrases.

For a polyvalent predicate such as *eat*, with optional defaulting on the internal argument, we will employ a different mechanism to indicate the optionality inherent in the function. First, notice that the lexical semantics (i.e., typing) for a verb like *eat* could in fact be represented as lexical closure, as shown in (29) below.

(29) $\lambda x \lambda e \exists y{:}\texttt{food}[eat(e,x,y)]$

Given the presence of true transitive behavior for such verbs, however, there would also have to exist another entry for *eat* with the following typing:

(30) $\lambda y \lambda x \lambda e[eat(e,x,y)]$

The general strategy in Generative Lexicon theory is to avoid such multiple listings of related word senses (cf. Pustejovsky, 1995). For adicity-reducing alternations, such as that with *eat*, we can imagine projecting the defaulting property of a function's argument directly as an expression of its own type, where all default parameters contribute towards the actual type of the expression. This is exactly what makes functional closure distinct from lexical closure.

Consider a class of functions, defined within the λ-calculus, where the elements are able to provide for the conditions on their own closure. That is, the function is able to decay according to specific conditions on how it is defined. To this end, assume an operator, λ^*, which creates a *branching type* for the variable it takes. The λ^*-operator allows us to distinguish in our typing system, between expressions which take default arguments from those requiring true arguments. Let us define the λ^*-operator as follows. Assume the basic axioms for the λ-calculus, with the following addition:

(31) a. $(\lambda^* x \phi)\alpha = \phi'$, where every occurrence of x is replaced by α, unless,
b. $\alpha = \epsilon$, where every occurrence of x is replaced by the Skolem constant of x.

Now the type of *eat* can be given as a *branching type*, $\substack{e \\ \epsilon} \rightarrow (e \rightarrow \mathcal{E})$, and the logical expression associated this type is given in (32).

(32) $\lambda^* y \lambda x \lambda e[eat(e, x, y)]$

This expression abstracts y as an argument that is *always* existentially closed, at least, and can in fact be bound to a specific individual constant if one is present. Observe that if no legitimately typed argument is present, the λ^*-operator acts to close the variable, and move on to the next conversion.

(33) a. $\lambda^* y \lambda x \lambda e[eat(e, x, y)](john)$
b. $\lambda e \exists y[eat(e, john, y)]$

We will denote a branching type with a fixed interpretation for a single branch as follows:

(34) $e \xrightarrow{\epsilon} \mathcal{E}$

In a way, the λ^*-operator defines a new class of functions constructed from the semantics of the classic λ-operator, with the additional property of permitting its own closure. We might define the semantics of λ^*-abstraction as in (35):

(35) Given a variable u of type a, and an expression α of type b, then $[\![(\lambda^* u\alpha)]\!]^{M,g}$ is that function which either:

(i) for any object k in D_a, $f(k) = [\![\alpha]\!]^{M,g'}$, where g' is just like g but that $g'(u) = k$, or

(ii) given an epsilon transition, there is at least a single object k in D_a, where $f(\epsilon) = [\![\exists u\alpha]\!]^{M,g'}$, where g' is just like g but that $g'(u) = k$.

This suggests that the grammatical distinctions between lexically-closed arguments (such as default and shadow arguments) and functionally-closed arguments (such as pragmatically-controlled deletion) are semantically derived, and accounted for by basic differences in the types of the lexical items involved. These distinctions are further articulated in Pustejovsky (1996b).

3 Complementary Shadowing and Coercion

Let us now return to the cases of complementary shadowing mentioned in the first section. Recall the peculiar behavior of shadowing with *risk*.

(36) a. Mary risked `death` to save her son.
b. Mary risked *her life* to save her son.

(37) a. Mary risked `illness`.
b. Mary risked *her health*.

(38) a. Mary risked `bankruptcy`.
b. Mary risked *her own solvency*.

Fillmore and Atkins (1990) argue that the semantic roles associated with the verb *risk* must include the following functions:

i. `harm`: a potential unwelcome development or result;

ii. victim: the individual who will potentially be harmed;

iii. deed: the act which brings about the risky situation;

iv. goal: that which is achieved by the act;

v. *possession*: something valued by the victim.

According to their analysis, there is no obvious compositional solution to the selection and assignment of the appropriate case roles as exhibited in the above data, and this is seen as evidence in support of a construction grammar solution. From our perspective, however, the complementary expression of the HARM and POSSESSION roles in the sentences above is indicative of a deeper relation between the roles and the nominalizations that express them. Namely, the HARM role always indicates the privation of a possible POSSESSION role, but in complementary distribution. That is, *death* is the privative of *life*, *illness* is the privative of *health*, etc. The reason that this is important is because one of the possible complementation types for the *harm* role is, in fact, logically related to the *possession* role; namely *losing one's life*, *losing one's health*, etc. Furthermore, if these roles stand in complementary distribution then they are probably just different expressions of the same underlying role. It is this position I will argue.

I will argue that the shadowing behavior of *risk* follows from the following motivated assumptions:

(a) The direct object argument ARG2 is typed as carrying a feature PRIVATIVE.

(b) There is no distinction between harm and possession roles.

(c) The verb may coerce argument ARG2, giving rise to variable (nominally dependent) interpretations of the type of harm. Essentially, PRIVATIVE may act as a function over an NP denotation.

(d) The semantics of lexical items makes reference to privative/non-privative pairs. The qualia structure provides the semantic mechanism for reconstructing a privative interpretation for a lexical item.

We can express the conditional nature of the resulting state in the qualia structure of the verb *risk* directly. The central component to the semantics of *risk* involves two parameters:

- an activity performed by an individual;
- the possibility of a resulting state that is unwelcome.

The coercive behavior of the privative is illustrated below in (39).

(39) Metonymic Reconstruction by Coercion:
a. PRIVATIVE(*health*) = *losing one's health*
b. PRIVATIVE(*life*) = *losing one's life*
c. PRIVATIVE(*solvency*) = *losing once's solvency*

The qualia encode the explanatory aspects of a verb's semantics. Hence, the qualia structure for *risk* can be given as follows:

(40) $\lambda e_2 \lambda x \lambda e_1$ [*risk*: FORMAL=$[P(e_2,x) \vee \neg P(e_2,x)] \wedge$ AGENTIVE=$[R(e_1,x)]$]

This states that an individual x, by performing the activity e_1, will end up in the state e_2, being either P or $\neg P$. If risking something is to bring about the possibility that what holds now of relevance, ψ, may in fact not hold after the activity, then we are close to capturing this relation in the expression above.

Now, how does this relate to the possible grammatical forms? There are three basic syntactic patterns for the verb *risk*, as repeated below in (15):

(41) a. Mary risked **death** to save John.
b. Mary risked *her life* to save John.
c. Mary risked *losing her life* to save John.

I will assume that PRIVATIVE acts as a coercion operator over a semantic form (e.g., the semantic form for *health*), and provides for a metonymic reconstruction of the privative typing environment when it is not directly satisfied by the complement phrase itself.

One might ask how this type of coercion operates, since in no conventional sense is *death* part of the meaning of the NP *her life* in (41b). Furthermore, how is the information encoded that *death* is privative in nature? I will argue that this information does in fact constitute part of the analytic knowledge we have of the semantics of a concept such as *life*; namely, knowing that the concept stands in opposition to the concept *death*. A notion such as privative is not unlike other inter-lexical semantic relations, such as hyponymy, but it is distinct in that the concept being referred to is the pairing of two predicates or relations, and the semantics must reflect this fact. I will refer to such supralexical semantic representations or meta-predicate relations as *projective structures* (cf. Pustejovsky, 1991, 1996b).

In order to better understand the nature of projective structures, let us review some basic assumptions regarding the lexical type lattice which structures the types employed by the semantics.

Briefly, the lexical lattice structure can be defined as those typed feature structures corresponding to conventionally construed types, together with the types generated by the application of *projective transformations* on this category, including $\neg$, $<$, $\circ$, $>$, *act*, and $=$. These transformations, together with qualia-based relations between types, define a circumscribed semantic field of concepts.

Formal specifications of the predicative variable in QUALIA, where ARGSTR and EVENTSTR are fixed as most general types, give rise to the projective conclusion space of predicates concerning **existence**. The complete relational top lattice types are as follows: *Logical Types*: MODAL, QUANTIFICATION, RELATIONAL, and TEMPORAL; *Material Types*: EXISTENCE, SPACE, FORM, MOTION, SUBSTANCE, MENTAL.

For each type, τ, at each level, l, the projective conclusion space, $\Phi(\tau_l)$, is computed from the application of all possible one-, two-, and three-step transformations over the base type (cf. Pustejovsky, 1991). This procedure and an explanation of the type structure syntax for the concept lattice is presented in Pustejovsky (1996b).

As an example of this method for generating types, consider the following derivation. The top type EXISTENCE is expressible of any single object, without constraints. Assume this corresponds to the predicative expression $P(x)$. Corresponding to this logical predicate are the English verbs *exist*, *be*, and the phrasal verb *have being*. The one-step transformation applying the $\neg$-operator to this predicate, $\pi_1(P) \Longrightarrow \neg P(x)$, corresponds to the phrasal verbs *not exist* and *have no existence*. The set of types derived from two-step transformations are given below:

(2) **Two-Step Transformations:**
$(\pi_1(P) \Longrightarrow \pi_2(P, \neg P(x)) \Longrightarrow \neg P(x)\ \pi_2\ P(x))$:
a. $\neg P(x) < P(x)$: *arise*, *begin*, *become*, and the phrasal verb *come into existence*.
b. $P(x) < \neg P(x)$: *cease*, *disappear*, *perish*, and the phrasal verb *pass away*.
c. $P(x) < P(x)$: *continue*, *endure*, *last*, *remain*, *stay*.

The set of types derived from three-step transformations are also part of the projective conclusion space and is represented as follows:

(3) **Three-Step Transformations:**
$(\pi_1(P) \Longrightarrow \pi_2(P, \neg P(x)) \Longrightarrow \pi_3([\neg P(x)\ \pi_2\ P(x)]))$:
a. $cause(y, (\neg P(x) < P(x)))$: *bring into being*.
b. $cause(y, (P(x) < \neg P(x)))$: *annihilate*, *nullify*.

Let us now return to the question of how a privative concept relates to a lexical item such as *life*. From the brief exposition above, it is clear that semantic structures larger than lexically-encoded concepts can be constructed with the help of projective transformations. Let us define an *opposition structure* as a minimal projective conclusion space, making use of the single transformation of binary opposition on a predicative expression. For a predicate such as *live*, the trivial one-step transformation of negation gives that concept lexically associated with "not alive". The concept of *death* actually involves a two-step transformation from *live*, including an inchoative transformation as well, modeled here as a partial ordering over event variables. Projective structures are useful for several reasons. Not only do they model what appears to be the intuitive nature of the relations between concepts, as with the opposition structures shown above, but they give rise to grammatical consequences as well (cf. Pustejovsky, 1996b, for discussion).

Each member entering into an oppositional pairing, such as *solvency* and *bankruptcy*, *life* and *death*, and so forth, will encode that it is part of an opposition structure in its qualia. For example, for an opposition-structure, $\mathcal{P}$, denoting the pair *life* and *death*, the relevant aspects of the lexical semantics for these lexical items is as follows:

(42) $$\begin{bmatrix} \textbf{life(e}^S\textbf{)} \\ \text{CONST} = \textbf{part\_of(e}^S\textbf{,}\mathcal{P}\textbf{)} \\ \ldots \end{bmatrix}$$

(43) $$\begin{bmatrix} \textbf{death(e}^P\textbf{.e}^S\textbf{)} \\ \text{CONST} = \textbf{part\_of(e}^P\textbf{.e}^S\textbf{,}\mathcal{P}\textbf{)} \\ \ldots \end{bmatrix}$$

Now let us return to the sentence in (41a). The privative requirement coming from the governing verb is directly satisfied by the lexical item *death*, while in (41c), a Gerundive Phrase denotes the same typing. The case in (41b) is likewise coerced to a privative but the reconstruction is performed semantically (and not explicitly in the syntax) by reference to the opposition structure of the complement.

Notice how the qualia structure encodes not a *conditional probability* such as (16),

(44) $\diamond R(e_1, x) \rightarrow \neg P(e_2, x)$

but rather a *necessary uncertainty*:

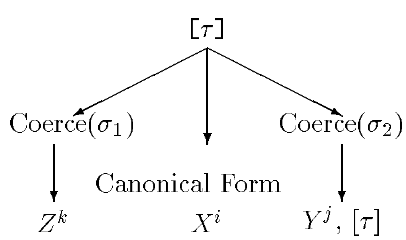
(45) $\Box R(e_1, x) \; > \; [P(e_2, x) \vee \; \neg P(e_2, x)]$

This correctly denotes the possibility that the activity in $R(e_1, x)$ results either in the continuation of the relevant state holding of x, $P(e_2, x)$, or its negation, $\neg P(e_2, x)$. Given the explanation of the lexical shadowing alternation in terms of the option of choosing the privative form of a predicate P or its non-privative, we would expect, in fact, three possible grammatical forms for the complement, which is of course the case (cf. (41) above). This exemplifies yet another construction where the deep semantic typing surfaces not only as the *canonical syntactic form*, but also in coerced and reconstructed forms as well, as illustrated in (46).

(46) a. risk his life (coerced positive)
b. risk death (underlying privative)
c. risk losing his life (reconstructed privative from positive)

The canonical syntactic form and its family of licensed coercions is called the *phrasal paradigm* for that type. This is illustrated for any type in (47).

(47)



Further properties of how elements of the phrasal paradigm are constrained to ensure recoverability of the underlying type are discussed in Pustejovsky (1995).

4 Argument Expression in Complex Relations

In this section, I discuss the nature of argument expression in a certain class of verbs, which I will refer to as *complex relations*. The selectional properties of these verbs are similar in many respects to the complementary shadowing cases discussed above. These are verbs taking a *dot object* as one of its arguments. A dot object is a Cartesian product of types, used for representing the semantics of concepts such as *book*, *lecture*, *city*, and other complex types in the language (cf. Pustejovsky, 1996). For example, the noun *book* is logically polysemous between two senses, as illustrated in (48) below.

(48) a. Mary doesn't believe the book.
Type(*book*) = `info`
b. John sold his books to Mary.
Type(*book*) = `physobj`

This behavior is in fact very common in language, and has a variety of manifestations, as the sentences below indicate.

(49) a. Eno the cat is sitting on yesterday's newspaper.
Type(*newspaper*) = `physobj`
b. Yesterday's newspaper really got me upset.
Type(*newspaper*) = `info`

(50) a. Mary is in Harvard Square looking for the Bach sonatas.
Type(*sonata*) = `physobj`
b. We won't get to the concert until after the Bach sonata.
Type(*sonata*) = `event`

(51) a. I have my lunch in the backpack.
Type(*lunch*) = `food`
b. Your lunch was longer today than it was yesterday.
Type(*lunch*) = `event`

(52) a. The phone rang during my appointment.
Type(*appointment*) = `event`
b. My next appointment is John.
Type(*appointment*) = `human`

What is interesting about the above pairs is that the two senses are related to one another in a specific and non-arbitrary way. The apparently contradictory nature of the two senses for each pair actually reveals a deeper structure relating these senses, what I will call a *dot object* (cf. Pustejovsky, 1995). For each sense pair, there is a relation which "connects" the senses in a well-defined way. I will characterize this structure as a Cartesian type product of n types, with a particularly restricted interpretation. The product $\tau_1 \times \tau_2$, of types τ_1 and τ_2, each denoting sets, is the ordered pair $<t_1, t_2>$, where $t_1 \in \tau_1$, $t_2 \in \tau_2$. Obviously, the pairing alone does not adequately determine the semantics of the dot object; rather, there must exist a relation R which relates the elements of τ_1 and τ_2; i.e., $R(t_1, t_2)$. This relation must be seen as part of the definition of the semantics for the dot object $\tau_1 \cdot \tau_2$ to be well-formed.

The set of relations, $\{R_i\}$, can be seen as specialized type product operators, where the specific relation is built into the constructor itself:

(53) $\{R_i\} = \cdot_{R_1}, \cdot_{R_2}, \ldots, \cdot_{R_n}$

For nouns such as *book*, *disc*, and *record*, the relation R is a species of "containment," and shares grammatical behavior with other container-like concepts. For example, we speak of information *in* a book, articles *in* the newspaper, as well as songs *on* a disc. This containment relation is encoded directly into the semantics of a concept such as *book* —i.e., $hold(x, y)$— as the FORMAL quale value. For other dot object nominals such as *prize*, *sonata*, and *lunch*, different relations will structure the types in the Cartesian product, as we see below. Let us say that, for any dot object, α, defined as a Cartesian product, $\tau_1 \cdot \tau_2$, the following must hold:

(54) $\lambda x.y \exists R[\alpha(x : \tau_1.y : \tau_2) : R(x, y) \ldots]$

The lexical structure for *book* as a dot object can then be represented as in (55).

(55)
$$\left[\begin{array}{l} \textbf{book} \\ \text{ARGSTR} = \left[\begin{array}{l} \text{ARG1} = \texttt{y:information} \\ \text{ARG2} = \texttt{x:phys\_obj} \end{array}\right] \\ \text{QUALIA} = \left[\begin{array}{l} \texttt{information}\cdot\texttt{phys\_obj\_lcp} \\ \text{FORM} = \texttt{hold(x,y)} \\ \text{TELIC} = \texttt{read(e,w,x.y)} \\ \text{AGENT} = \texttt{write(e,v,x.y)} \end{array}\right] \end{array}\right]$$

This translates roughly to the following logical form:

(56) $\lambda x.y[book(x\!: \texttt{physobj}.y\!: \texttt{info}) : hold(x, y) \wedge \lambda w \lambda e[read(e, w, x.y)]$
$\wedge \exists e' \exists v[write(e', v, x.y)]]$

Nouns such as *sonata*, *lunch*, and *appointment*, on the other hand, are structured by entirely different relations, as explored below. What is important to note, however, is that the dot object construction (i.e., the type product) allows otherwise contradictory types to be combined into a single type. From a conceptual development point of view, this suggests that complex types are in fact learned later than simple or unified types (cf. Pustejovsky, 1995, for some discussion).

In the previous section, we saw that certain classes of nominals, i.e., endocentric dot objects, have qualia values which are relations selecting for the dot objects directly. The examples we encountered above were the *read* and *write* relations as selected by the TELIC and AGENTIVE qualia, respectively, for a concept such as *book*. This is illustrated schematically below:

(57) a. $\lambda y.z\lambda x\lambda e[read(e, x, y.z)]$
b. $\lambda y.z\lambda x\lambda e[write(e, x, y.z)]$

What does it mean, however, for a verb to select a dot object as an argument and is there any way to distinguish such a relation from those that do not or cannot select a dot object? To answer this question, let us compare the selectional distribution of a lexical item typed as a dot object, with a word carrying the type of one of the dot elements; namely, *book* versus *story*.

(58) a. **Type**(*book*) = `physobj.info`
b. **Type**(*story*) = `info`

Given this distinction, there should be contexts in which one type is selected for and the other is prohibited. This is, in fact, what we observe. Notice that while the verb *read* permits direct selection of both types, the verb *tell* does not allow *book* as the head of its complement.

(59) a. Mary read a book.
b. Mary read a story.

(60) a. Mary told a story.
b. *Mary told a book.

While both books and stories are informational in nature, a story, unlike a book, need not be realized as a physical object. To illustrate this distinction, consider what the logical interpretations for the sentences in (59a) and (60a) are. For a type such as *book*, we will say that the dot elements of the type product are both extensional. Hence, for a dot object α, the following holds:

(61) EXISTENTIAL DISTRIBUTION:
$\Box\forall\alpha\forall x.y[\alpha(x.y) \rightarrow \exists\alpha_1\exists\alpha_2[\alpha_1(x) \wedge \alpha_2(y)]]$

This property holds for a complex type such as *book* because the FORMAL quale is an *extensional relation* between two individuals, viz. *hold*. The consequences of this are that both dot elements are existentially closed when existential force is given to the dot object. Hence (62c) follows as the interpretation of (62a).

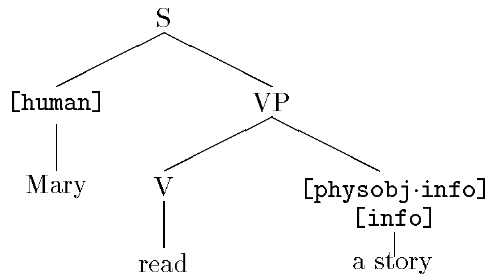
(62) a. Mary read a book. $\Longrightarrow$
b. $\exists y.z\exists e[read(e, m, y.z) \wedge book(y.z)] \Longrightarrow$
c. $\exists y.z\exists e[read(e, m, y.z) \wedge book(y.z) \wedge physobj(y) \wedge info(z)]$

Because the noun *story* is a simple type, however, no such interpretation is possible, and all that is existentially asserted of (63a) is the story itself.

(63) a. Mary told a story. $\Longrightarrow$
b. $\exists x \exists e[tell(e,m,x) \wedge story(x)]$

Nevertheless, the verb *read* is able to coerce its complement in (59b) into both components of the complex type, **physobj.info**. The behavior of the verb *read* relative to the selection of a non-dot object complement illustrates the coercive nature of the predicate, as shown below (cf. Pustejovsky, 1995).

(64)



What is interesting about this example is that the type of the noun *story*, by virtue of the coercion, has been embedded within a complex type, which brings with it, a very different quantificational force than that seen when selected by the verb *tell* in (60a).

(65) a. Mary read a story. $\Longrightarrow$
b. $\exists y.z \exists w \exists e \exists P[read(e,m,y.z) \wedge P(y.z) \wedge story(w) \wedge w = z] \Longrightarrow$
c. $\exists y.z \exists w \exists y \exists e \exists P[read(e,m,y.z) \wedge P(y.z) \wedge physobj(y)$
$\wedge\, story(w) \wedge w = z]$

Thus, the NP *a story* appears to inherit additional existentially quantified properties by virtue of the semantic context within which it appears. Notice that the interpretation of the NP has not been type shifted in the sense of Partee and Rooth (1993), but rather embedded in a metonymic reconstruction, while preserving the underlying semantics of the NP, i.e., it is coerced.[1]

Thus far we have explored the selectional distinctions between *read* and *tell*, and this has brought us a bit closer to understanding what it means for a predicate to select a dot object complement. It was observed that endocentric dot objects have the property of existential distribution, repeated below:

[1] It should be pointed out that verbs like *tell* do not appear to be able to coerce their complements in the same way that *believe* and *enjoy* are able to. Such considerations and other grammatical distinctions between coercing and non-coercing predicates lead us to distinguish between two types of selection, *active* and *passive*.

i. *Active Selection*: Enables coercion, and allows accommodation to the required type.

(66) Existential Distribution:
$\Box\forall\alpha\forall x.y[\alpha(x.y) \rightarrow \exists\alpha_1\exists\alpha_2[\alpha_1(x) \wedge \alpha_2(y)]]$

Now recall from our previous discussion how the verb *read* is able to impose an interpretation on a complement that it would otherwise not carry, as in (60), where **physobj** was imposed on an informational concept. Notice that a similar phenomenon occurs when the complement carries no intrinsic interpretation as an informational concept, as in (67).

(67) Mary read the subway wall.

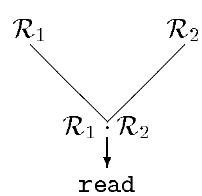
Furthermore, observe that the subcategorization behavior for *read* permits the following structures.

(68) a. Mary read the book.
b. Mary read the book of articles.
c. Mary read the articles in the book.
d. Mary read the articles.

The form in (68b) is, of course, not entirely due to the verb but also to the semantics of the head noun. Nevertheless, these considerations together with the coercive behavior of *read* strongly suggest that it is a complex relation, formed from relations which each take an element of the dot object as an argument.

A complex relation is one which decomposes into simpler component parts, each of which is itself a relation. For a relation such as *read*, which we modeled as selecting for a dot object in complement position, let us say that there are as many component relations as there are elements in the dot object selected for, in this case, two. This is illustrated schematically in (69) below.

(69)



ii. *Passive Selection*: No coercion possibilities; requires direct selection of type by the complement.

I will have little more to say about this distinction here; this topic is taken up in the context of the theory of selection in Pustejovsky (1996b).

If a *book* is a complex type, then the characteristic functions over this type must be decomposable and identifiable. Intuitively, we can separate the visual perception of the physical aspect of the dot object `physobj·info` from the understanding or comprehending of its informational aspect. Let us call these two relations $\mathcal{R}_1$ and $\mathcal{R}_2$, respectively. They are furthermore structured by a temporal precedence relation, $<_\propto$, since I must first see in order to comprehend the text. On this view, the verb *read* denotes a Cartesian type over relations, $\mathcal{R}_1.\mathcal{R}_2$, with a similar restriction to that mentioned in the previous section, that there must exist a relation structuring these relational elements. Hence, something like the following must hold for a complex relation which selects for a dot object:

(70) RELATION DECOMPOSITION:
a. $\lambda x.y\lambda z\lambda e[\mathcal{R}_1.\mathcal{R}_2(e,z,x.y)] \Longrightarrow$
b. $\lambda x\lambda y\lambda z\lambda e_1\lambda e_2[\mathcal{R}_1(e_1,z,x) \wedge \mathcal{R}_2(e_2,z,y) \wedge <_\propto (e_1,e_2)]$

The qualia structure for the verb *read* is given as follows:

$$(71)\quad \left[\begin{array}{l} \textbf{read} \\ \text{ARGSTR} = \left[\begin{array}{l} \text{ARG}_1 = \textbf{x:ind} \\ \text{ARG}_2 = \textbf{y.z:print-matter} \end{array}\right] \\ \text{EVENTSTR} = \left[\begin{array}{l} \text{E}_1 = \textbf{e}_1\textbf{:process} \\ \text{E}_2 = \textbf{e}_2\textbf{:process} \\ \text{RESTR} = <\circ_\propto \end{array}\right] \\ \text{QUALIA} = \left[\begin{array}{l} \text{FORMAL} = R_2(\textbf{e}_2\textbf{,x,z}) \\ \text{AGENTIVE} = R_1(\textbf{e}_1\textbf{,x,y}) \end{array}\right] \end{array}\right]$$

In order to model the semantics of this complex relation more precisely, one might view such structures in terms of relational algebraic operations. Let us begin with our observation above that *read* might be viewed as a Cartesian product (where $\dot{\cup}$ denotes disjoint union):

(72) $\times : \mathcal{R}(\tau_1) \times \mathcal{R}(\tau_2) \rightarrow \mathcal{R}(\tau_1 \dot{\cup} \tau_2)$

But this is not quite right, for what is unique about a predicate such as *read* is that each relation in the product shares an *attribute* value. That is, the subject of R is the same as the subject of S. Therefore, let us call *read* the *join* of the two relations, R and S; more specifically, let us refer to it as a Θ-join operation over these relations (cf. Maier, 1983).

(73) $[X\Theta Y] : \mathcal{R}(\tau_1) \times \mathcal{R}(\tau_2) \rightarrow \mathcal{R}(\tau_1 \dot{\cup} \tau_2)$

Let Θ be a comparison operator on the common domain of X and Y, $W(X) = W(Y)$. We will say that a tuple from $R \times S$ satisfies the conditions defined by the filter $X\Theta Y$, if components with respect to the parameters X and Y stand in relation Θ. Hence, the Θ-join is defined according to this condition, for two relations R and S:

(74) $R[X \Theta Y]S \;:=\; s_{X\Theta Y}(R \times S)$

A specific example of this that will be relevant to our discussion is a particular constraint on the relational product called an *equijoin*.

(75) $R[X = Y]S \;:=\; s_{X=Y}(R \times S)$

Now, we can return to the sentence in (59a), and provide for the complete interpretation. Making use of both Existential Distribution and Relation Decomposition, we arrive at the following derivation:

(76) a. Mary <u>read</u> a book. $\Longrightarrow$
b. $\exists y.z \exists e[read(e, m, y.z) \wedge book(y.z)] \Longrightarrow$
c. $\exists y.z \exists e[read(e, m, y.z) \wedge book(y.z) \wedge physobj(y) \wedge info(z)] \Longrightarrow$
d. $\exists y \exists z \exists e_1 \exists e_2[read_1(e_1, m, y) \wedge physobj(y) \wedge read_2(e_2, m, z)$
$\wedge\, info(z) \wedge <_{\propto} (e_1, e_2)]$

The machinery creating complex relational types can also be used to explain some peculiar properties of certain "cooperative activity" predicates such as *rent* and *lease*, as well as "weakly symmetric" predicates, such as *meet*, *touch*, and *debate*. Consider briefly the behavior of *rent*. This verb is interesting because it allows for two subcategorizations, each corresponding to a distinct interpretation of the verb. Observe in (77) how the directionality of the relation is affected or dictated by the prepositional phrase selected for (cf. Bierwisch, 1983, Jackendoff, 1983).

(77) a. Mary <u>rented</u> the room from John.
b. Mary <u>rented</u> the room to John.

The interpretation given in one sentence entails the interpretation provided for in the other. The fact that the "renting event" entails two subparts or subevents suggests that the relation is itself complex in nature, where the relation actually refers to both perspectives on the transaction, i.e., the "giving" and the "taking" events.

This predicate can be modeled as a Θ-join complex relation, $R[X\Theta Y]S$, with the comparison operator constraining Y_R, the second parameter of R, to be identical to Y_S, the second parameter of S.

(78) $R[Y_R = Y_S]S \;:=\; s_{Y_R=Y_S}(R \times S)$

It is interesting to note that, in (79), the VP is semantically underspecified with respect to which subevent is being referred to. The semantics of the subject in each case acts to strongly bias the interpretation to one perspective or the other.

(79) a. The landlord <u>rented</u> the apartment.
b. The tenant <u>rented</u> the apartment.

5 Conclusion

In this paper I have attempted, all too briefly, to characterize the different types of optionality on the expression of arguments in linguistic theory. I introduced a distinction between types of arguments that a predicate may take, and the methods with which they achieve existential closure in the semantics. Default and shadow arguments, I argued, are governed by a principle of *lexical closure*, whereas arguments that are dropped or deleted in more conventional polyvalency phenomena are governed by *functional closure*. Two types of shadowing phenomena were investigated, complementary and argument shadowing. Research on co-compositional shadowing was not reported here, but can be found in Pustejovsky (1996c).

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