Persian perception verbs

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Abstract

The syntax and semantics of verbs related to sensory perception has been a continuing subject of investigation in the field of linguistics. In terms of syntax, defining what types of grammatical arguments these verbs take and how and why the types of these arguments vary among perception verbs have been the main topics of discussion. In terms of semantics, the focus has primarily been on determining the thematic roles of the arguments of perception verbs and, relatedly, on determining what relationship they have to the event that they predicate of. This paper makes three main contributions. First, we present a novel analysis of perception verbs in Persian, a significant number of which feature complex predicates. In doing so, we encounter two main challenges: 1. The requirement for a general syntax/semantic for complex predicates that works in both perceptual and non-perceptual contexts; and 2. A generalized analysis that accounts for semantic entailments (which we here discuss only in the context of perception verbs). Second, in meeting challenge 1, we provide a novel account of Persian complex predicates using Glue Semantics. Third, we discuss how the makeup of Persian complex predicates provides significant insights into the overall conceptual/argument structure of perception constructions more generally, especially with regards to languages, like English, where this is hidden by fuller lexicalization.

1 Background

The syntax, semantics, and syntax–semantics interface of sensory perception verbs has been an ongoing topic of research in linguistics.[1] In terms of syntax, defining what types of grammatical arguments these verbs take and how and why the types of these arguments vary among perception verbs have been the main topics of discussion. In terms of semantics, one of the main questions has been to determine the thematic roles of the arguments of perception verbs and, relatedly, to determine what relationship they have to the event that they predicate of.

Perception verbs in Persian are mainly complex predicates, although there are a few simplex/lexicalized perception verbs. (1) exemplifies the aural paradigm, which has both complex (1a,c) and simplex cells (1b).[2]

(1) a. Actor ⟨ACTOR,STIMULUS⟩
gušˇ kard-an
ear do-INF
X listen to Y

[1]We thank the audience of LFG23 and our reviewers for their comments and questions. We particularly thank Miriam Butt and Ida Toivonen for extended discussion of various aspects of this paper. All remaining errors are our own.

[2]Glosses are abbreviated as follows: AUX–auxiliary, IPFV–imperfect, INF–infinitive, OM–object marker, PP–past participle, PRES–present tense, PAST–past tense, SBJV–subjunctive, SG–singular, PL–plural.

b. Experiencer ⟨EXPERIENCER,STIMULUS⟩
šenid-an
hear-INF
X hear Y

c. Percept ⟨STIMULUS,(EXPERIENCER)⟩

sedā dād-an	be guš āmad-an/resid-an
sound give-INF	to ear come-INF/arrive-INF
Y emitted a sound (to X)	Y was heard (by X)

This paper makes three contributions. First, we present a novel analysis of perception verbs in Persian, many of which involve complex predicates. There are two main challenges:

1. It requires a general syntax/semantics for complex predicates that works in both perceptual and non-perceptual contexts; and
2. The generalized analysis must account for semantic entailments (which we here discuss only in the context of perception verbs).

Second, in meeting challenge 1, we provide a novel account of Persian complex predicates using Glue Semantics. Third, we briefly discuss how the structure of Persian perceptual complex predicates give important clues to the conceptual/argument structure of perception constructions[3] more generally, especially with regards to languages, like English, where this is hidden by fuller lexicalization.

In sum, our main research question in this paper is this:

Q How can we give a consistent semantics for (the relevant) Persian light verbs that covers both perceptual constructions like (1) as well as their uses in physical contexts, like (2–3), in which they function as lexical/main (i.e., non-light) verbs?

(2) Max ketāb-rā be Sam dā-d.
Max book-DO to Sam give-PAST.3SG
'Max gave the book to Sam.'

(3) Max be madrese āma-d.
Max to school come.PAST-PAST.3SG
'Max came to school.'

We next turn to the general, cross-linguistic semantics of perception verbs.

2 The semantics of perception verbs

Sensory perception verbs (e.g., *hear*, *listen*, *sound*) have been an ongoing topic of research in linguistics and philosophy of language (see Dretske 1969, Akmajian

[3]We use this term only descriptively/pre-theoretically.

1977, Barwise 1981, Viberg 1984, 2001, 2008, 2015, Evans and Wilkins 2000, Jackendoff 2007, Gisborne 2010, Asudeh and Toivonen 2012, Poortvliet 2018, among others). In terms of syntax, defining what types of grammatical arguments these verbs take and how and why the types of these arguments vary among perception verbs have been the main topics of discussion. In terms of semantics, one of the main questions has been to determine the sorts of macro-roles (e.g. ACTOR; Foley and Van Valin 1984) and thematic roles (e.g., EXPERIENCER, AGENT, STIMULUS) to assign the subjects and complements of perception verbs and to determine what relationship they have to the event or situation described by the clause that the perception verb heads.

Consider (4), where the subjects of the perception verbs play different roles.

(4) a. Max listened to the music.
b. Max heard the music.
c. Context: Max is heard coughing badly.
Max sounds ill.

In (4a), Max is the ACTOR,[4] whereas in (4b), Max is the EXPERIENCER. Indeed, in (4a) Max is both the ACTOR and EXPERIENCER. In (4c), Max is a STIMULUS.

Table 1 categorizes English perception verbs based on the thematic roles of their arguments (following Viberg 1984).[5] The table illustrates that paradigm cells can be filled by the same form. Take the verb *smell*, whose form is three-ways ambiguous between Actor, Experiencer and Percept, which have distinctive conceptual/argument structures. Similarly, a perception may be distinguished in a single cell, but not be distinguished in two others, such as *look*, whose form is ambiguous between Actor and Percept, but cannot correspond to an Experiencer argument structure, since there is a dedicated verb, *see*, in that cell. It is therefore useful to refer not to particular verbs but rather to the underlying sensory modalities: respectively, *aural*, *visual*, *olfactory*, *gustatory*, *tactile* (following Asudeh and Toivonen 2012); this will also be a feature in our analysis, in order to capture entailments.

Sensory perception verbs in Persian have not received sustained formal linguistic analysis to the same extent as physical predication. As noted previously, Persian verbal constructions in general are of two main kinds: simplex/fully lexicalized verbs and complex predicates (CPREDs) as shown in (5) and (6) respectively.

(5) Max mādar-aš-rā mi-bin-ad
Max mother-POSS.3S-OM DUR-see.PRES-3S
'Max sees her/his/its mother.'

[4] We treat this as an ACTOR not an AGENT, because the verb that introduces the role in Persian, *kardan* ('do'), is compatible with predications that are non-agentive, e.g. *Max gerye kard* ('Max cried.')

[5] In order to keep thing simple enough, we follow the classic typology of Viberg (1984), and set aside the refinements presented in Viberg (2015). Also note that we use slightly different labels for our categories: *actor* instead of Viberg's *activity*, *experiencer* instead of *experience-based/experience*, and *percept* instead of *source-based/copulative*.

Actor ⟨ACTOR,STIMULUS⟩	**Experiencer** ⟨EXPERIENCER,STIMULUS⟩	**Percept** ⟨STIMULUS,EXPERIENCER⟩
look X look at Y	see X see Y	look Y look P to X
listen X listen to Y	hear X hear Y	sound Y sound P to X
touch/feel X touch/feel Y	feel X feel Y	feel Y feel P to X
taste X taste Y	taste X taste Y	taste Y taste P to X
smell X smell Y	smell X smell Y	smell Y smell P to X

Table 1: English perception verbs classified by their arguments' thematic roles

(6) Max be mādar-aš [negāh mi-kon-ad]$_{\text{CPRED}}$
Max to mother-POSS.3S look DUR-do.PRES-3S
'Max looks at her/his/its mother.'

The sentence in (5) illustrates the use of a simplex verb, whereas (6) contains a CPRED, consisting of a noun, *negāh*, as its Preverbal Element (PVE) and a Light Verb (LV), *kard-an* ('do', which can also be a main verb in some cases).

Persian CPREDs can be made of various PVEs of bare predicative category, including nouns, adjectives, and verbal stems, or oblique-marked nouns in the form of prepositional phrases. The verbal element, LV, in CPREDs can vary, since several lexical verbs contribute to forming CPREDs, making such constructions very productive (for sample accounts of Persian CPREDs, see Barjasteh 1983, Khanlari 1986, Bateni 1989, Mohammad and Karimi 1992, Ghomeshi and Massam 1994, Goldberg 1996, Karimi-Doostan 1997, Müller 2010, Megerdoomian 2012, Nash and Samvelian 2016, and Rafiee Rad 2019, among others). The particular simplex verbs that contribute to the formation of the principal CPRED perception verbs, with informal glosses of their meanings, are presented in (7):

(7) a. *kardan*: to do/cause
b. *dādan*: to give
c. *zadan*: to hit
d. *āmadan*: to come
e. *residan*: to arrive

Note that these simplex verbs can also be light verbs in physical/non-perceptual CPREDs, e.g. *čādor zadan* ('to pitch a tent').

Table 2 presents a somewhat simplified list of Persian perception verbs (both simplex and CPREDs).[6,7] This table shows that the use of complex predicates is prevalent in Persian perception constructions.

[6] There are many other verbal constructions used to express perception in Persian, such as *be guš āmad-an* 'sound', *be guš resid-an* 'sound', *be mašām resid-an* 'smell', among others.

[7] This table is based on the one provided by (Viberg 1984: 131, table 6). Note that Viberg uses *be nazar resid[-]an* in the cell for visual percept, but this is actually closer to the English verb *seem*.

Actor ⟨ACTOR, STIMULUS⟩		Experiencer ⟨EXPERIENCER, STIMULUS⟩	Percept ⟨STIMULUS, EXPERIENCER⟩	
negāh kard-an look do-INF X look at Y		did-an see-INF X see Y	be češm āmad-an/resid-an to eye come-INF/arrive-INF Y was seen by X	
guš kard-an ear do-INF X listen to Y		šenid-an hear-INF X hear Y	sedā dād-an sound give-INF Y emitted a sound to X	be guš āmad-an/resid-an to ear come-INF/arrive-INF Y was heard by X
lams kard-an touch do-INF X touch Y (possibly inadvertently)	dast zad-an hand hit-INF X feel Y (necessarily intentionally)	ehsās kard-an sense do-INF X feel Y	hes dād-an sense give-INF Y emitted a feel to X	
maze kard-an taste do-INF X taste Y		(maze) hes kard-an (taste) sense do-INF X taste Y	maze dād-an taste give-INF Y emitted a taste to X	
bu kard-an smell do-INF X smell Y		(bu) hes kard-an (smell) sense do-INF X smell Y	bu dād-an smell give-INF Y emitted a smell to X	

Table 2: Persian perception verbs classifed by their arguments' thematic roles

3 A general semantics for light verbs

The Glue meaning constructors for the five LVs in Table 2 are shown in (10)–(14).[8] The main intuition to keep in mind is that each LV has a meaning constructor that has been factored out of its physical and perceptual guises, such that it applies to either as a modifier. The resulting interpretations for corresponding sample physical light verb constructions and perceptual light verb constructions involving these LVs are shown in the appendix.

Before turning to these, let's also specify the following entailment relations between thematic roles and macro-roles, in (8),[9] and between different perceptual predicates, in (9).

(8) a. AGENT, EXPERIENCER, SOURCE $\subseteq$ ACTOR &
AGENT $\cap$ EXPERIENCER $\cap$ SOURCE $= \varnothing$ — SUBJ roles

b. THEME, STIMULUS $\subseteq$ UNDERGOER &
THEME $\cap$ STIMULUS $= \varnothing$ — OBJ roles

c. GOAL, EXPERIENCER, SOURCE $\subseteq$ LOCATION &
GOAL $\cap$ EXPERIENCER $\cap$ SOURCE $= \varnothing$ — OBL roles

(9) $\mathbf{P}_{(a)ural}, \mathbf{P}_{(v)isual}, \mathbf{P}_{(o)lfactory}, \mathbf{P}_{(g)ustatory}, \mathbf{P}_{(t)actile} \subseteq \mathbf{P}_{sense}$ (=$\mathbf{P}$)

A consequence of the entailments in (8) is that something can be, e.g., an AGENT and an ACTOR or an EXPERIENCER and an ACTOR without inconsistency. Similarly, the entailments in (9) allow particular verbs to control which perceptual verbs they are compatible with; combinations that don't support the modality in question are blocked pragmatically.[10,11]

(10) *kardan*
(↑ PRED) = 'do'

$$\lambda\mathcal{R}\lambda y\lambda x\lambda v.\mathcal{R}(y)(x)(v) \wedge \textsc{undergoer}(v) = y \wedge \textsc{actor}(v) = x :$$
$$[(\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap (\uparrow_\sigma \textsc{event}) \multimap \uparrow_\sigma] \multimap$$
$$[(\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap (\uparrow_\sigma \textsc{event}) \multimap \uparrow_\sigma]$$

$$\left(\left\{\begin{array}{l|} \lambda Q\lambda y\lambda x\lambda v.(\mathbf{do}(Q))(v) \wedge \textsc{patient}(v) = y \wedge \textsc{agent}(v) = x : \\ (\uparrow_\sigma \textsc{pvp}) \multimap (\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap (\uparrow_\sigma \textsc{event}) \multimap \uparrow_\sigma \\ \lambda Q\lambda y\lambda x\lambda v.(\mathbf{do}(Q))(v) \wedge \textsc{stimulus}(v) = y \wedge \textsc{experiencer}(v) = x : \\ (\uparrow_\sigma \textsc{pvp}) \multimap (\uparrow \textsc{obj})_\sigma \multimap (\uparrow \textsc{subj})_\sigma \multimap (\uparrow_\sigma \textsc{event}) \multimap \uparrow_\sigma \end{array}\right\}\right)$$

[8]In the entry for *kardan* in (10), PVP stands for PRE-VERBAL ELEMENT. See page 8 below for brief further discussion.

[9]The labels "SUBJ roles", etc., indicate which grammatical functions these roles would be mapped to in active voice.

[10]For simplicity, we here set aside causative uses of *kardan*, as in *garm kardan* ('to cause to become warm'), but this can be accommodated by a further appropriate template and does not effect the substance of the analysis offered here.

[11]In order to accommodate the large formulas below, we use the following abbreviations when necessary: ACT(OR), AG(ENT), EXP(ERIENCER), LOC(ATION), STIM(ULUS), TH(EME), UND(ERGOER).

(11) *dādan*

$(\uparrow \text{PRED})$ = 'give'

$$\lambda \mathbb{R} \lambda z \lambda y \lambda x.\mathbb{R}(z)(y)(x)(v) \wedge \text{LOC}(v) = z \wedge \text{UND}(v) = y \wedge \text{ACT}(v) = x :$$
$$[(\uparrow \text{OBL})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma] \multimap$$
$$[(\uparrow \text{OBL})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma]$$
$$\left(\left\{\begin{array}{l|} \lambda z \lambda y \lambda x \lambda v.\textbf{give}(v) \wedge \text{GOAL}(v) = z \wedge \text{TH}(v) = y \wedge \text{AG}(v) = x : \\ (\uparrow \text{OBL})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma \\ \lambda z \lambda y \lambda x \lambda v.\mathbf{P}_{\neg v}(v) \wedge \text{EXP}(v) = z \wedge \text{STIM}(v) = y \wedge \text{SOURCE}(v) = x : \\ (\uparrow \text{OBL})_\sigma \multimap (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma \end{array}\right\}\right)$$

(12) *zadan*

$(\uparrow \text{PRED})$ = 'hit'

$$\lambda \mathcal{R} \lambda y \lambda x \lambda v.\mathcal{R}(y)(x)(v) \wedge \text{UND}(v) = y \wedge \text{ACT}(v) = x :$$
$$[(\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma] \multimap$$
$$[(\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma]$$
$$\left(\left\{\begin{array}{l|} \lambda y \lambda x \lambda v.\textbf{hit}(v) \wedge \text{PATIENT}(v) = y \wedge \text{AGENT} = x : \\ (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma \\ \lambda y \lambda x \lambda v.\mathbf{P}_t(v) \wedge \text{STIMULUS}(v) = y \wedge \text{EXPERIENCER}(v) = x : \\ (\uparrow \text{OBJ})_\sigma \multimap (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma \end{array}\right\}\right)$$

(13) *āmadan*

$(\uparrow \text{PRED})$ = 'come'

$$\lambda y \lambda R \lambda x \lambda v.R(x)(v) \wedge \text{LOC}(v) = y \wedge \text{UND}(v) = x \ \wedge \ \textbf{proximal}(v, y, \textbf{origo}) :$$
$$(\uparrow \text{OBL})_\sigma \multimap [(\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma] \multimap$$
$$[(\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma]$$
$$\left(\left\{\begin{array}{l|l} \lambda x \lambda v.\textbf{arrive}(v) \wedge \text{THEME}(v) = x : & \lambda x \lambda v.\mathbf{P}_{a \vee v}(v) \wedge \text{STIM}(v) = x : \\ (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma & (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma \end{array}\right\}\right)$$

(14) *residan*

$(\uparrow \text{PRED})$ = 'arrive'

$$\lambda y \lambda R \lambda x \lambda v.R(x)(v) \wedge \text{LOC}(v) = y \wedge \text{UND}(v) = x :$$
$$(\uparrow \text{OBL})_\sigma \multimap [(\uparrow \text{SUBJ})_\sigma \multimap ((\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma)] \multimap$$
$$[(\uparrow \text{SUBJ})_\sigma \multimap ((\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma)]$$
$$\left(\left\{\begin{array}{l|l} \lambda x \lambda v.\textbf{arrive}(v) \wedge \text{THEME}(v) = x : & \lambda x \lambda v.\mathbf{P}_a(v) \wedge \text{STIM}(v) = x : \\ (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma & (\uparrow \text{SUBJ})_\sigma \multimap (\uparrow_\sigma \text{EVENT}) \multimap \uparrow_\sigma \end{array}\right\}\right)$$

We next turn to an example analysis, which also demonstrates our syntactic approach.

4 Syntax and semantics: Analysis

The example that we will analyze in this section is:

(15) Qazā-ro bu kar-d-am
food-OM smell do-PAST-1.SG
'I smelled the food.'

The reader can verify from Table 2 that this an instance of the Actor paradigm.

Our analysis licenses the syntax of complex predication with the following annotated c-structure rule:

(16) $\text{V}' \rightarrow \underset{@\text{COMP-PRED}(\downarrow,\_)}{\text{PVE}} \quad \underset{@\text{COMP-PRED}(\_,\downarrow)}{\text{V}}$

We treat a complex predicate as a normal V′ that consists of a pre-verbal element (PVE) followed by a V (the light verb). PVE is a meta-category defined as follows:

(17) PVE = {A | N | PP}

Note that we do need to allow for PPs, since P-based PVEs can occur with their prepositional object, but there is no evidence that other lexical categories form phrases in their PVE guise.

The f-structure is defined by a template/macro (Dalrymple et al. 2004; Asudeh et al. 2013):

(18) COMP-PRED(X,Y) := %CPRED = (X PRED FN)-(Y PRED FN)
$\downarrow = \text{X} \Rightarrow (\uparrow_\sigma \text{ PVP}) = \text{X}_\sigma$
$\downarrow = \text{Y} \Rightarrow [\uparrow = \text{Y}\backslash\text{PRED}] \wedge [(\uparrow \text{ PRED}) = \text{‘\%CPRED’}]$

The COMP-PRED template takes two arguments. The licensing rule in (16) requires that the first argument, X, is instatiated to the f-structure that is the correspondent of the PVE and the second argument, Y, is instantiated to the f-structure that is the correspondent of V, the light verb. The first line of the template uses the PRED decomposition notation (Crouch et al. 2011; Asudeh et al. 2013) to get the base PRED functions, FN, of the PVE and the light V. The FN is not a semantic form, so is not uniquely instantiated. Therefore, it's harmless that both instances of the template call in the rule do this. We use a local name, %CPRED to store, the FN value of the complex predicate; a local name is a variable that is instantiated only in a given f-description (Dalrymple et al. 2019). The second line tests whether the ↓ f-structure is the PVE's. This is only true if we are dealing with the instance of @COMP-PRED that is called by the PVE. In that case, the value of the feature PVP (PRE-VERBAL-PROPERTY) is equated with the semantic structure of the pre-verbal element. This has the consequence that the sem-structure of the PVE is embedded inside the sem-structure of the light verb. The third line tests whether the ↓ f-structure is the light V's. This is only true if we are dealing with the instance of @COMP-PRED that is called by V. In that case, the restriction operator (Kaplan and Wedekind 1993) is used to state that the f-structure of the entire V′ complex predicate structure is the same as that of the light V, *except* for its PRED (which is simplex). However, the second conjunct then fills in the PRED of the complex predicate structure by stating that the PRED is a semantic form built out of the complex %CPRED value from the first line.

The light verb in this example is *kardan* ('do'). We repeat its entry from (10) above, but also make its category explicit now:

(19) *kardan* V
(↑ PRED) = 'do'

$\lambda R \lambda y \lambda x \lambda v. R(y)(x)(v) \wedge \textsc{undergoer}(v) = y \wedge \textsc{actor}(v) = x :$
$[\, \boxed{(\uparrow \textsc{obj})_\sigma} \multimap \boxed{(\uparrow \textsc{subj})_\sigma} \multimap \boxed{(\uparrow_\sigma \textsc{event})} \multimap \uparrow_\sigma] \multimap$
$[\, \boxed{(\uparrow \textsc{obj})_\sigma} \multimap \boxed{(\uparrow \textsc{subj})_\sigma} \multimap \boxed{(\uparrow_\sigma \textsc{event})} \multimap \uparrow_\sigma]$

$$\left(\left\{ \begin{array}{l} \lambda Q \lambda y \lambda x \lambda v.(\mathbf{do}(Q))(v) \wedge \textsc{patient}(v) = y \wedge \textsc{agent}(v) = x : \\ \boxed{(\uparrow_\sigma \textsc{pvp})} \multimap \boxed{(\uparrow \textsc{obj})_\sigma} \multimap \boxed{(\uparrow \textsc{subj})_\sigma} \multimap \boxed{(\uparrow_\sigma \textsc{event})} \multimap \uparrow_\sigma \\ \quad \\ \lambda Q \lambda y \lambda x \lambda v.(\mathbf{do}(Q))(v) \wedge \textsc{stim}(v) = y \wedge \textsc{exp}(v) = x : \\ \boxed{(\uparrow_\sigma \textsc{pvp})} \multimap \boxed{(\uparrow \textsc{obj})_\sigma} \multimap \boxed{(\uparrow \textsc{subj})_\sigma} \multimap \boxed{(\uparrow_\sigma \textsc{event})} \multimap \uparrow_\sigma \end{array} \right| \right\} \right)$$

We also use colour boxes in the annotation here to visually indicate correspondence between elements in the Glue terms in (19) and parts of the representations in Figures 1 and 2, which follow immediately below.

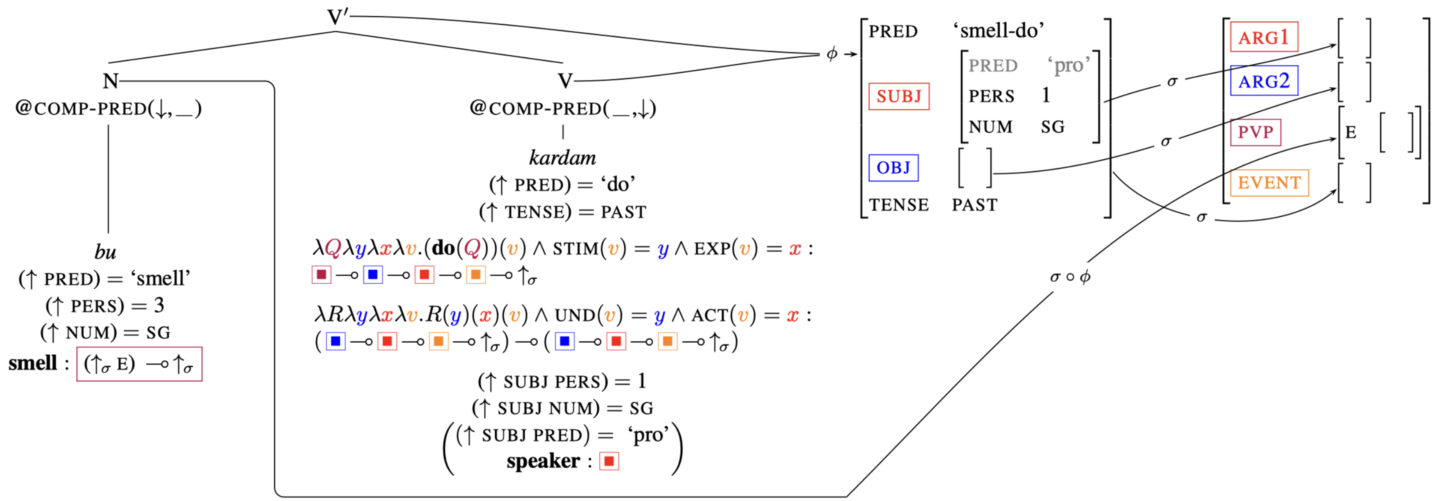

Figure 1: C-structure, f-structure and semantic structure for (15)

bu

$$\textbf{smell} : \boxed{\color{purple}\blacksquare}$$

kardam$_1$

$$\lambda Q \lambda y \lambda x \lambda v.(\textbf{do}(Q))(v) \wedge \textsc{stim}(v) = y \wedge \textsc{exp}(v) = x : \boxed{\color{purple}\blacksquare} \multimap \boxed{\color{blue}\blacksquare} \multimap \boxed{\color{red}\blacksquare} \multimap \boxed{\color{orange}\blacksquare} \multimap \uparrow_\sigma$$

$$\lambda y \lambda x \lambda v.(\textbf{do}(\textbf{smell}))(v) \wedge \textsc{stim}(v) = y \wedge \textsc{exp}(v) = x : \boxed{\color{blue}\blacksquare} \multimap \boxed{\color{red}\blacksquare} \multimap \boxed{\color{orange}\blacksquare} \multimap \uparrow_\sigma$$

kardam$_2$

$$\lambda R \lambda y \lambda x \lambda v.R(y)(x)(v) \wedge \textsc{und}(v) = y \wedge \textsc{act}(v) = x : (\boxed{\color{blue}\blacksquare} \multimap \boxed{\color{red}\blacksquare} \multimap \boxed{\color{orange}\blacksquare} \multimap \uparrow_\sigma) \multimap (\boxed{\color{blue}\blacksquare} \multimap \boxed{\color{red}\blacksquare} \multimap \boxed{\color{orange}\blacksquare} \multimap \uparrow_\sigma)$$

$$\lambda y \lambda x \lambda v.(\textbf{do}(\textbf{smell}))(v) \wedge \textsc{stim}(v) = y \wedge \textsc{exp}(v) = x \wedge \textsc{und}(v) = y \wedge \textsc{act}(v) = x : \boxed{\color{blue}\blacksquare} \multimap \boxed{\color{red}\blacksquare} \multimap \boxed{\color{orange}\blacksquare} \multimap \uparrow_\sigma$$

Qazāro

$$\iota z.\textbf{food}(z) : \boxed{\color{blue}\blacksquare}$$

$$\lambda x \lambda v.(\textbf{do}(\textbf{smell}))(v) \wedge \textsc{stim}(v) = \iota z.\textbf{food}(z) \wedge \textsc{exp}(v) = x \wedge \textsc{und}(v) = \iota z.\textbf{food}(z) \wedge \textsc{act}(v) = x : \boxed{\color{red}\blacksquare} \multimap \boxed{\color{orange}\blacksquare} \multimap \uparrow_\sigma$$

kardam$_3$

$$\textbf{speaker} : \boxed{\color{red}\blacksquare}$$

$$\lambda v.(\textbf{do}(\textbf{smell}))(v) \wedge \textsc{stim}(v) = \iota z.\textbf{food}(z) \wedge \textsc{exp}(v) = \textbf{speaker} \wedge \textsc{und}(v) = \iota z.\textbf{food}(z) \wedge \textsc{act}(v) = \textbf{speaker} : \boxed{\color{orange}\blacksquare} \multimap \uparrow_\sigma$$

$$\lambda P \exists v.P(v) : (\boxed{\color{orange}\blacksquare} \multimap \uparrow_\sigma) \multimap \uparrow_\sigma$$

$$\exists v.(\textbf{do}(\textbf{smell}))(v) \wedge \textsc{stim}(v) = \iota z.\textbf{food}(z) \wedge \textsc{exp}(v) = \textbf{speaker} \wedge \textsc{und}(v) = \iota z.\textbf{food}(z) \wedge \textsc{act}(v) = \textbf{speaker} : \uparrow_\sigma$$

Figure 2: Glue proof for (15), given Figure 1

4.1 Some consequences

Our analysis assumes a general framework for argument structure roles in which there are both macro-roles (Foley and Van Valin 1984; Van Valin and LaPolla 1997) and thematic roles, similarly to the use of macro-roles in HPSG (Pollard and Sag 1994), although without the more granular predicate-specific 'micro-roles'. From the perspective of general neo-Davidsonian event semantics (Parsons 1990), the use of macro-roles is less familiar. Our approach addresses this by defining macro-roles as simple, set-theoretic generalizations over thematic roles:

(20) a. AGENT, EXPERIENCER, SOURCE $\subseteq$ **ACTOR**

b. THEME, STIMULUS $\subseteq$ **UNDERGOER**

c. GOAL, EXPERIENCER, SOURCE $\subseteq$ **LOCATION**

This allows an EXPERIENCER or SOURCE to be an ACTOR or a LOCATION. We can restrict the consequence of this by stating that ACTOR $\cap$ LOCATION $= \varnothing$. This in turn has the consequence that *some* EXPERIENCERs are ACTORs, while *others* are LOCATIONs; mutatis mutandis, the same goes for SOURCEs.[12]

Similarly, we restrict thematic roles to be non-overlapping subsets of macro-roles:

(21) a. AGENT $\cap$ EXPERIENCER $\cap$ SOURCE $= \varnothing$

b. THEME $\cap$ STIMULUS $= \varnothing$

c. GOAL $\cap$ EXPERIENCER $\cap$ SOURCE $= \varnothing$

This in turn allows us to make simple, high-level mapping generalizations (the original motivation behind macro-roles):

(22) a. SUBJECT $\xrightarrow{\sigma}$ ACTOR

b. OBJECT $\xrightarrow{\sigma}$ UNDERGOER

c. OBLIQUE $\xrightarrow{\sigma}$ LOCATION

This is provisional for now, but we see no reason why this approach could not be integrated into the argument structure and linking approaches of Asudeh and Giorgolo (2012), Findlay (2016), et seq.

5 Comparison to previous LFG approaches

Alsina (1993, 1996, 1997) and Butt (1993, 1995, 2014) set the standard for subsequent LFG analyses of complex predicates, also building on noteworthy earlier

[12]A reviewer notes that this amounts to claiming that there are two kinds of EXPERIENCER (same for SOURCE). That is the effect, but it's important to note that, since there is only an undifferentiated EXPERIENCER thematic role, any one predicate can only have one EXPERIENCER (same for SOURCE), per the usual functional understanding of Thematic Uniqueness (Carlson 1984; Asudeh and Toivonen 2012).

work by Mohanan (1994). We have built on many of their insights. However, we have taken into account not just the interaction between lexicon, c-structure, and f-structure, as in the prior, syntactically focused work, but have also added compositional semantics and a unified event semantics analysis of verbs as light verbs and main verbs. In contrast, the syntax-only approaches either do not say much about lexical semantics and its interaction with compositional semantics (Alsina) or else use an ad hoc lexical semantic formalism whose compositional properties are under-explored (Butt). Similarly, the separately stipulated principles of *Event Fusion* and *Argument Fusion* in Butt (1995) simply fall out of our compositional event semantics. Moreover, the notion of an "incomplete predicate" that Butt introduces also falls out, because each light verb has a core/common meaning that is so radically underspecified that it does not contain a contentful predicate over events and so is incomplete in this sense.

Our use of the restriction operator in complex-predicate formation is anticipated by Butt (1995), based on initial suggestions by Kaplan and Wedekind (1993). However, Butt's criticism that it leads to lexical stipulation does not apply, because:

1. There are only a small number of light verbs that each consistently behave in the same way.

2. Complex-predicate formation occurs in the syntax, as in Butt's system.

Butt (1995) also mentions a then-nascent LFG+Glue sketch of complex predicate formation (Dalrymple et al. 1993), but the modern avatar of this approach is Lowe (2015). Lowe proposes a theory of complex predicates in which complex predication is not reflected in the f-structure at all and is instead handled by a co-headed c-structure rule, which eschews restriction, and lexical specifications of Glue meaning constructors for complex predicates. This amounts to a regular lexical entry for the main verb, including a non-complex PRED value (contra prior approaches by Alsina and Butt). The light verb's entry in contrast has no PRED and contributes only a modificational meaning constructor, which introduces the predication (e.g., the function **let**) only in the semantics.

Note that Lowe strips the subcategorization information out of the f-structure, assuming like us and much other LFG+Glue work that subcategorization is handled at the syntax-semantics interface, i.e. directly captured by the requirements of resource-sensitive composition (Kuhn 2001; Asudeh 2004, 2012). The various parts of Lowe's analysis are thus:

- A c-structure co-head rule for complex predication formation

- Regular lexical entries for main verbs like Urdu *likh* ('write')

- Special lexical entries for light verbs like Urdu *de* ('let')

- Argument structure and linking are handled at the syntax-semantics interface and s(emantic)-structure, based on Asudeh and Giorgolo (2012) and subsequent work by various LFG+Glue scholars.

Our approach builds on both the "traditional" LFG approach, to use Lowe's term, of Alsina/Butt/Mohanan and the LFG+Glue approach, as exemplified by Lowe (2015). We are thus offering both a synthesis and an augmentation of previous approaches.

We agree with Lowe that Argument Fusion is poorly understood and its lack of formalization in the XLE perhaps reflects deep problems with any potential formalization. However, we do not assume a principle of Argument Fusion (or Event Fusion). These instead follow directly from our formalization. We disagree with Lowe that complex predication should only be reflected in the semantics. The role of f-structure has sometimes been taken to include aspects of semantics, but it really represents only syntactic predication. The misleading term "semantic form" for PRED values has no doubt contributed to the confusion. In short, we take it as truer to the spirit of LFG to reflect the complexity of complex predication at the level that represents syntactic predication, which is f-structure. Lowe also implicitly appeals to lexical ambiguity in his treatment of light verbs, since non-light uses of these verbs do contribute syntactic predication and other f-structural information. Lastly, the traditional approach emphasizes the syntax of complex predication and the LFG+Glue approach of Lowe emphasizes the semantics, but neither previous approach gives a full and general picture of the syntax and compositional semantics of complex predicates. In contrast, our approach accounts for the light verbs in Persian in their light and non-light uses, and captures both the syntax and semantics of complex predication.

The consideration of perception verbs proved crucial in this regard, because it more fully revealed the properties of complex predication in Persian (a closely related language to Urdu) that similarly makes extensive use of complex predication and whose complex predicates have also formed a focus of study in linguistic theory.

6 Conclusion

Our main research question in this paper has been:

Q How can we give a consistent semantics for (the relevant) Persian light verbs that covers both perceptual constructions like (1) as well as their uses in physical contexts?

We answered the question by providing lexical semantics for the required predicates in Glue Semantics such that they can be used in both physical and perceptual contexts. This approach also builds on previous work on perception verbs more generally and work on macroroles and thematic roles. Although it may not be obvious from our presentation, our ultimate touchstone for the kind of lexical semantics we are doing is the work of John Beavers and Andrew Koontz-Garboden (among others, Beavers and Koontz-Garboden 2020; Beavers et al. 2021).

We presented a new analysis of complex (PVE+LV) perception verbs in Persian, which poses a challenge because of the convergence between the physical and perceptual applications of the same LVs. Addressing this challenge necessitates a comprehensive syntax and semantics framework for complex predicates that functions effectively in both contexts. Our approach is based on those of Butt (1995, 2014) and Lowe (2015), but is ultimately different from both prior approaches. We factored out the shared information as macro-roles within a modifier that can compose either with the physical or perceptual meaning constructor; these meaning constructors in turn fix the thematic roles such that they are consistent with the macro-roles. This captures entailments between the classes:

1. Members of the actor class entail corresponding members (row-mates in Tables 1 and 2) of the experiencer class.
2. Members of the experiencer class in turn entail corresponding members of the percept class.
3. By transitivity, members of the actor class also entail corresponding members of the percept class.

Lastly, our analysis shows how lexical entailments between different predicates, in particular *āmadan* ('to come') and *residan* ('to arrive'), can be captured. The two verbs contribute distinct syntactic predications (respectively having PRED values 'come' and 'arrive'), but are built around the same predicate on events in the meaning language of the Glue analysis, namely **arrive**. The meaning constructor for *āmadan* can be schematized as **arrive** $\wedge\ p$, where p is the indexical proposition about proximity to the speaker/hearer (as appropriate). It is easy to observe then that:

1. The train came at noon. $\rightarrow$ The train arrived at noon.
   $\because$ **arrive**$(v) \wedge p \rightarrow$ **arrive**(v)
2. The train arrived at noon. $\rightarrow$ The train came at noon.
   $\because$ **arrive**$(v) \not\rightarrow$ **arrive**$(v) \wedge p$

It seems to us that this overall approach can also shed light on perception verbs in languages, like English, where they are more heavily lexicalized and therefore less compositionally transparent.

A Appendix

(23) a. Max in kār-rā kard.
Max this work-OM do.PAST.3SG
'Max did this work.'

Physical (main verb or light verb)
$\exists v.\textbf{do}(v) \wedge \textsc{undergoer}(v) = \textbf{this.work} \wedge \textsc{actor}(v) = \textbf{max} \wedge \textsc{patient}(v) = \textbf{this.work} \wedge \textsc{agent}(v) = \textbf{max}$

b. Max [bu-ye ghazā] [hes kard].
Max smell-EZ food sense do.PAST.3SG
'Max smelled food.'

Perceptual (light verb; experiencer type)[13]
$\exists v.\textbf{P}(v) \wedge \textsc{undergoer}(v) = \textbf{smell}(\textbf{*food}) \wedge \textsc{actor}(v) = \textbf{max} \wedge \textsc{stimulus}(v) = \textbf{smell}(\textbf{*food}) \wedge \textsc{experiencer}(v) = \textbf{max}$

(24) a. Max be Sam ketāb-rā dād.
Max to Sam book-OM give.PAST.3SG
'Max gave Sam the book.'

Physical (main verb or light verb)
$\exists v.\textbf{give}(v) \wedge \textsc{location}(v) = \textbf{sam} \wedge \textsc{undergoer}(v) = \textbf{the.book} \wedge \textsc{actor}(v) = \textbf{max} \wedge \textsc{goal}(v) = \textbf{sam} \wedge \textsc{theme}(v) = \textbf{the.book} \wedge \textsc{agent}(v) = \textbf{max}$

b. Max bu-ye xub mi-dād.
Max smell-EZ good DUR-give.PAST.3SG
'Max smelled good.'

Perceptual (light verb; percept class)[14]
$\exists v \exists x.\textbf{P}_{\neg v}(v) \wedge \textsc{location}(v) = x \wedge \textsc{undergoer}(v) = \textbf{nom}(\textbf{good}(\textbf{smell})) \wedge \textsc{actor}(v) = \textbf{max} \wedge \textsc{experiencer}(v) = x \wedge \textsc{stimulus}(v) = \textbf{nom}(\textbf{good}(\textbf{smell})) \wedge \textsc{source}(v) = \textbf{max}$

(25) a. Max Sam-rā zad.
Max Sam-OM hit.PAST.3SG
'Max hit Sam.'

Physical (main verb or light verb)
$\exists v.\textbf{hit}(v) \wedge \textsc{undergoer}(v) = \textbf{sam} \wedge \textsc{actor}(v) = \textbf{max} \wedge \textsc{patient}(v) = \textbf{sam} \wedge \textsc{agent}(v) = \textbf{max}$

b. Max lebās-rā dast zad.
Max clothes-OM hand hit.PAST.3SG
'Max felt the clothes.'

Perceptual (light verb; actor class)
$\exists v.\textbf{P}_t(v) \wedge \textsc{undergoer}(v) = \textbf{the.clothes} \wedge \textsc{actor}(v) = \textbf{max} \wedge \textsc{stimulus}(v) = \textbf{the.clothes} \wedge \textsc{experiencer}(v) = \textbf{max}$

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[13] Note that we use Link's (1983) here to represent the meaning of the mass noun *food*.

[14] In the analysis of (24b), we assume a nominalizing operation that maps the object common noun of type $\langle e, t \rangle$ to the type e entity in question, following the extensional treatement of Chierchia's (1984) nominalizing operator, $^{\cap}$, in Partee (1986). This would be associated with another modifying meaning constructor, which we leave aside here to avoid (even more) clutter.

(26) a. Max be madrese ā-mad.
Max to school come-PAST.3SG
'Max came to school.'

Physical (main verb or light verb)
$\exists v.\textbf{arrive}(v) \wedge \textsc{location}(v) = \textbf{school} \wedge \textsc{actor}(v) = \textbf{max} \wedge \textsc{proximal}(v, \textbf{school}, \textbf{origo}) \wedge \textsc{theme}(v) = \textbf{max}$

b. nur-i az dur be češm āma-d.
light-INDEF from afar to eye come.PAST-PAST.3SG
'A light was seen from afar.'

Perceptual (light verb; percept class)
$\exists v \exists x \exists y.\mathbf{P}_{a \vee v}(v) \wedge \textbf{light}(y) \wedge \textsc{undergoer}(v) = y \wedge \textsc{actor}(v) = x \wedge \textsc{stimulus}(v) = y \wedge \textsc{experiencer}(v) = x$

(27) a. Max be madrese resid.
Max to school arrive.PAST.3SG
'Max arrived at school.'

Physical (main verb or light verb)
$\exists v.\textbf{arrive}(v) \wedge \textsc{location}(v) = \textbf{school} \wedge \textsc{actor}(v) = \textbf{max} \wedge \textsc{theme}(v) = \textbf{max}$

b. Sedā-ye ajib-i az ānjā be guš resid.
sound-EZ strange-INDEF from there to ear arrive.PAST.3SG
'A strange sound was heard from there.'

Perceptual (light verb; percept class)
$\exists v \exists x \exists y.\mathbf{P}_{a}(v) \wedge \textbf{sound}(y) \wedge \textbf{strange}(y) \wedge \textsc{undergoer}(v) = y \wedge \textsc{actor}(v) = x \wedge \textsc{stimulus}(v) = y \wedge \textsc{experiencer}(v) = x$

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