Restriction for Morphological Valency Alternations:
The Urdu Causative

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1 Introduction

This paper further explores the use of the *Restriction Operator* (Kaplan and Wedekind 1993)[1] for a computational treatment of complex predication. The Restriction Operator has already been applied to a treatment of syntactically formed complex predicates (Butt, King and Maxwell 2003). It has not, however, so far been applied to morphologically formed complex predicates. In this paper, we present an implementation that uses restriction for both dealing with Urdu causatives (morphologically formed complex predicates) and Urdu permissives (syntactically formed complex predicates). The finite-state realizational model (Karttunen 2003) standardly used with the ParGram project (Butt et al. 1999, Butt et al. 2002) serves as the morphology-syntax interface. We also examine the interaction of the different types of complex predicates with one another and with periphrastic passive formation. As will be seen in the course of the paper, the use of the Restriction Operator raises some interesting architectural and theoretical issues, which we discuss in the concluding section (section 7). The structure of the paper is as follows. In section 2, we briefly discuss the challenges presented by complex predicates, and we contrast theoretical and computational perspectives. In section 3, we introduce the Restriction Operator and illustrate how it has previously been applied to Urdu permissives in the syntax. Section 4 provides some theoretical background to the analysis of causatives. In section 5, with respect to Urdu morphological causatives, we show how the Restriction Operator can operate within the morphological component. In section 6, we examine the interactions between syntactic and morphological complex predicates and passives and then explore the theoretical and computational implications.

2 Complex Predicates: Theoretical vs. Computational Perspectives

Complex predicate formation is akin to valency changing operations in that two clearly identifiable heads each contribute to a joint, complex argument structure. Some examples which have been dealt with extensively within an LFG perspective are shown in (1).[2]

(1)	a.	yassIn=nE	nAdyA=kO	gHar	banA-n-E	dI-yA
		Yassin=Erg	Nadya=Dat	house.M.Nom	make-Inf-Obl	give-Perf.M.Sg

‘Yassin let Nadya make a house.’ Urdu Permissive, Butt 1995

[1] Over the years since the completion of our dissertations in the early nineties, it has been a real pleasure to work together with Ron Kaplan and to profit from his endless patience and his formal insights and instincts. His linguistic instincts are often in complete opposition to ours, which means that our exposure to his sceptical perspective has served to hone our theoretical argumentation in a way that very few other challenges have been able to do. The result has been an extremely productive give-and-take between theory and computation, a give-and-take that we hope is reflected in this paper.

[2] The transcription of the Urdu examples here follows the simple ASCII based transcription used within the Urdu ParGram grammar. Capital letters stand for long vowels or retroflex consonants, capital H indicates aspiration and capital N shows nasalization of the preceding vowel.

b. nAdyA=nE xat likH lI-yA
Nadya=Erg letter.M.Nom write take-Perf.M.Sg
'Nadya wrote a letter (completely).' Urdu V-V, Butt 1995

c. nAdyA=nE kahAnI yAd k=I
Nadya=Erg story.F.Nom memory do-Perf.F.Sg
'Nadya remembered a/the story. Hindi/Urdu N-V, Mohanan 1994

d. L'elefant fa riure les hienes.
the elephant makes laugh the hyenas
'The elephant makes the hyenas laugh.' Catalan causative, Alsina 1997

It has been shown conclusively for all of these constructions by a variety of tests that the f(unctional)-structure must be monoclausal (i.e., there is no embedded subject) even though the a(rgument)-structure is complex (e.g., the discussions in Alsina 1996, 1997, Butt 1995, Mohanan 1994).

From a theoretical linguistic perspective, morphological valency changing operations have always been regarded as easy: they are generally accounted for by lexical rules or by different realizations in argument structure. Syntactic valency changing operations are also easy if a syntactic element can be treated as an operator which triggers the *addition* or *deletion* of an argument, as is the case in applicatives (addition) or passives (deletion). However, they are more complicated to account for if the subcategorization frame is *jointly* determined by different pieces of the syntax (verbs, nouns, or adjectives). As shown conclusively within LFG, this type of joint argument structure determination is exactly what occurs with true complex predicate formation as illustrated in (1) (again, see Alsina (1996), Butt (1995), Mohanan (1994)).

The analysis developed for complex predicate formation in Romance and Urdu/Hindi (Mohanan 1994, Butt 1995, Alsina 1996) entails that argument structure composition cannot be confined to the lexicon, as had until then been assumed by Lexical Mapping Theory,[3] but must also be able to take place in the syntax. Alsina's and Butt's LFG analyses led to a complication of LFG's architecture, but none that went beyond the possibilities of LFG's relatively powerful projection model, whereby any one linguistic projection (e.g., a-structure, c(onstituent)-structure, f-structure) can be related (directly, indirectly, or via an inverse relation) to another projection.

The core idea behind Linking Theory is attractively elegant and simple to implement. However, almost every new paper dealing with linking involves some form of "tinkering" with the standard theory as articulated in Bresnan and Zaenen (1990). That is, the discussion and introduction of new data generally also entails a proposal for a different version of the linking algorithm. Alsina (1996), for example, argues for a version of linking theory which is more subject-oriented than object-oriented (as instantiated by the [$\pm$o] feature). His version also integrates the notion of Proto-Roles (Dowty 1991, Van Valin 1977) into Linking Theory. Zaenen (1993) similarly proposes an incorporation of Proto-Roles into Linking Theory, but in a manner that is very different from Alsina's. Zaenen's (1993) proposal has been taken up by several researchers, especially those looking at linking in nominal domains. These papers, as well as ones which propose incorporating Optimality Theory constraints into Linking Theory, are too numerous to mention here (see any paper on linking in the LFG On-Line Proceedings of the last few years).

Computational accounts have generally shied away from implementing the complex architecture demanded by Alsina's and Butt's original analysis of syntactically formed complex predicates. The general perception among LFG computational linguists is that a-structure and its relation to f-structure and

[3]See Butt (2006) for an overview of the development of Mapping Theory.

c-structure are not theoretically well enough understood to warrant the effort of maintaining an extra projection since extra projections are computationally expensive and are complex to maintain from the point of view of grammar engineering (Butt et al. 1999). Analyses of complex predicates thus reveal an interesting tension between computational and theoretical approaches. As discussed in the next section, the introduction of the Restriction Operator represents an attempt to resolve this tension.

3 The Restriction Operator

Eschewing the use of a separate projection for a-structure, Kaplan and Wedekind (1993) introduced an account of V-V complex predicates that employed the *Restriction Operator*, which manipulates f-structure representations and operates within the lexicon. However, Butt (1994) showed that this initial solution requires a large amount of undesirable lexical stipulation and cannot account for the full combinatory power of complex predicate formation, which is a major drawback. Subsequent developments then allowed the Restriction Operator to operate within the syntax as well as the lexicon, thus avoiding the disadvantages brought up by Butt (1994). In particular, Butt, King, and Maxwell (2003) show that it is possible to implement the restriction analysis of complex predicates for Urdu in a way that seems to capture the original observations of Alsina and Butt satisfactorily.[4] In this section, we briefly present and discuss their solution in order to provide the necessary background for the discussion of the Restriction Operator as applied morphological causatives.

As already mentioned, complex predicate formation involves the composition of two separate argument structures, those of a main predicate and a so-called "light" verb (see Butt (2003) for a discussion of this syntactic category). This complex a-structure corresponds to a single monoclausal f-structure and this many-to-one correspondence is a hallmark of complex predicate formation. From the theoretical linking perspective, this means that an analysis must be formulated which maps a complex argument structure to a simplex f-structure. From the computational Restriction Operator perspective, the problem can be restated as one by which the f-structural subcategorization frame of the main verb needs to be manipulated in order to take the contribution of the light verb into account. From both perspectives, the essential problem is how to form a complex PRED value.

An example illustrating the problem is shown for Urdu in (2b) with the intransitive, unergative main verb 'cough' and the light verb 'give'. (2a) shows the simple, non-complex-predicate use of the verb 'cough'. In (2b) the main verb 'cough' combines with the light verb 'give' to form a complex argument structure by which 'Yassin' is the permitter of the action (agent), and 'Nadya' is the permissee who is allowed to perform a certain action. This means that 'Nadya' plays a dual role: that of matrix recipient/goal and that of embedded agent. In terms of the f-structure, 'Nadya' is a dative marked OBJ_θ.

(2) a. nAdyA kHANs-I
Nadya.Nom cough-Perf.F.Sg
'Nadya coughed.'

b. yassIn=nE nAdyA=kO kHANs-n-E dI-yA
Yassin=Erg Nadya=Dat cough-Inf-Obl give-Perf.M.Sg
'Yassin let Nadya cough.'

[4] Wedekind and Oersnes (2003) also show that this version of restriction can also be used to analyze analytic passive constructions in Danish.

An example of an Urdu permissive formed with a transitive main verb (‘make’) is shown in (3b) with the non-complex-predicate version in (3a). As in (2b), the permissee is in the dative.

(3) a.

nAdyA=nE	gHar	banA-yA
Nadya=Erg	house.Nom	make-Perf.M.Sg

‘Nadya made a house.’

b.

yassIn=nE	nAdyA=kO	gHar	banA-n-E	dI-yA
Yassin=Erg	Nadya=Dat	house.Nom	make-Inf-Obl	give-Perf.M.Sg

‘Yassin let Nadya make a house.’

As already mentioned, Butt (1995) proposes a theoretical analysis of the permissive using a(rgument)-structure and Linking Theory. Under this analysis, which is in line with Alsina’s proposals for causatives, the permissive (‘give’) is a light verb with three arguments. One of these arguments is an event which must be filled by the a-structure of a main verb or a complex predicate which itself is formed with a main verb. The full analysis for (3b), in which a biclausal a-structure links to a monoclausal f-structure, is shown in (4) and (5).[5]

(4) GIVE < ag go MAKE < ag th >>

(5)

$$\left[\begin{array}{ll} \text{SUBJ} & [\text{PRED } 'Yassin'] \\ \text{OBJ}_\theta & [\text{PRED } 'Nadya'] \\ \text{PRED} & '\text{give-make} < \_\_ , \_\_ , \_\_ >' \\ \text{OBJ} & [\text{PRED } 'house'] \end{array}\right]$$

Now consider the Urdu permissive from the perspective of a restriction analysis. From this f-structure oriented perspective, the effect of the permissive light verb is to “add” a new subject to the predication and to “demote” the main verb’s subject to a dative-marked indirect object. The sample lexical entries for the light verb ‘give’ and the main verb ‘make’ from this perspective are given in (6) and (7), respectively.

(6) (↑ PRED) = ′dE<(↑ SUBJ), %PRED2>′

(7) (↑ PRED) = ′banA<(↑ SUBJ), (↑ OBJ)>′

As can be seen, rather than being analyzed as a three-place predicate, the permissive *dE* ‘give’ is now rendered as a two-place predicate, in which the second argument is a local variable, %PRED2, which will be filled by the main verb predicate by the c-structure annotations, as discussed below. This approach avoids a complex merger of arguments (as assumed in the a-structure/linking approach) and is actually quite similar

[5]Note that the ‘Nadya’ again plays a dual role: that of matrix recipient/goal and that of embedded agent. In terms of the f-structure, however, ‘Nadya’ is realized as just one grammatical function: a dative marked OBJ_θ. This characteristic is one that sets complex predication apart from simple valency changing operations such as the mere deletion (i.e., passives) or addition of an argument (i.e., applicatives). Simple valency changing involves no argument merger or “fusion”. From a more broadly semantic perspective, the difference is that constructions identified as complex predicates involve modification of the primary event semantics, while simple addition/deletion operators maintain the same event semantics, but differ in the perspective on the event and their information-structural content.

to Minimalist analyses of complex predicates (e.g., Butt and Ramchand 2005), which are geared towards the combination of binary structures.

Restriction allows f-structures and predicates to be manipulated in a controlled and detailed fashion. The Restriction Operator, represented as ‘$\backslash$’, can be applied to an f-structure with respect to a certain feature in order to arrive at a restricted f-structure which does not contain that feature (see Kaplan and Wedekind (1993) for a formal definition). In the case of the permissive, it is used to restrict out the embedded subject so that a different grammatical function can be assigned to that argument.

In order to achieve this, restriction is used as part of the f-structure annotations on phrase structure rules. The rule in (8) shows the Restriction Operator within the c-structure rule for a complex predicate. In particular, the restriction on the V node is what allows the composition of the new PRED. The annotation states that the up node ($\uparrow$) comprising the complex predicate is the same as the down node ($\downarrow$) comprising the main verb, except that the SUBJ of the main verb is restricted out, as is the SUBJ and thematic object (OBJ-GO) of the complex predicate. This allows the former subject of ‘make’ to be identified as an OBJ-GO, via the $(\uparrow \text{OBJ-GO})=(\downarrow \text{SUBJ})$ equation in (8) (cf. (10)).[6]

(8)
$$\begin{array}{lcc} & (\textit{banAnE}) & (\textit{dIyA}) \\ \mathrm{V} \longrightarrow & \mathrm{V} & \mathrm{Vlight} \\ & \downarrow\backslash\text{SUBJ}\backslash\text{PRED}{=}\uparrow\backslash\text{SUBJ}\backslash\text{OBJ-GO}\backslash\text{PRED} & \uparrow=\downarrow \\ & (\uparrow \text{PRED ARG}2)=(\downarrow \text{PRED}) & \\ & (\downarrow \text{VFORM}) \text{ =c inf} & \\ & (\uparrow \text{OBJ-GO})=(\downarrow \text{SUBJ}) & \end{array}$$

Similarly, as the PRED is restricted out, a PRED can be constructed that is different from either of the PREDs stored in the lexicon (cf. (6) and (7)). In the case of the permissive, this is achieved via the equation $(\uparrow \text{PRED ARG}2)=(\downarrow \text{PRED})$ in (8), which builds a complex PRED by assigning the main verb’s ($\downarrow$) PRED to the second argument of the complex predicate’s PRED. ARG# provides a way of referring to specific argument positions within a PRED in the f-structure annotation and lexical rules (Crouch et al. 2006).

The restricted out f-structure of the main verb *banA* ‘make’ in (3b) is shown in (9). This is similar to the f-structure for the non-complex predicate in (3a) except that the case marking on the arguments and the tense and aspect information are those of the complex predicate, whose f-structure is shown in (10).

(9)
$$\begin{bmatrix} \text{PRED} & '\text{banA}<\text{SUBJ, OBJ}>'>' \\ \text{SUBJ} & \begin{bmatrix} \text{PRED} & '\text{Nadya}' \\ \text{CASE} & \text{dat} \end{bmatrix} \\ \text{OBJ} & \begin{bmatrix} \text{PRED} & '\text{gHar}' \\ \text{CASE} & \text{nom} \end{bmatrix} \\ \text{TNS-ASP} & \begin{bmatrix} \text{ASP} & \text{perf} \\ \text{TENSE} & \text{pres} \end{bmatrix} \end{bmatrix}$$

[6]The restriction of more than one feature is represented notationally by multiple instances of the restriction operator. So, the annotation in (8) indicates that both the PRED and the SUBJ are restricted out from the down f-structure, while the PRED, SUBJ, and OBJ-GO are restricted out from the up f-structure. Note that if the light verb can have a VFORM feature different from the infinitival feature required on the main verb by (8), then VFORM would also need to be restricted out. Here we show just the restriction of the grammatical functions to simplify the rule slightly.

In the final complex f-structure, the predicates *dE* ‘give’ and *banA* ‘make’ have been composed. The “embedded” SUBJ ‘Nadya’ has been restricted out as part of the composition. This is shown in (10).

(10)
$$\left[\begin{array}{ll}
\mathrm{PRED} & {}'\mathrm{dE}<\mathrm{SUBJ},\ {}'\mathrm{banA}<\mathrm{OBJ\text{-}GO},\ \mathrm{OBJ}>{}'>{}' \\
\mathrm{SUBJ} & \left[\begin{array}{ll} \mathrm{PRED} & {}'\mathrm{Yassin}{}' \\ \mathrm{CASE} & \mathrm{erg} \end{array}\right] \\
\mathrm{OBJ\text{-}GO} & \left[\begin{array}{ll} \mathrm{PRED} & {}'\mathrm{Nadya}{}' \\ \mathrm{CASE} & \mathrm{dat} \end{array}\right] \\
\mathrm{OBJ} & \left[\begin{array}{ll} \mathrm{PRED} & {}'\mathrm{gHar}{}' \\ \mathrm{CASE} & \mathrm{nom} \end{array}\right] \\
\mathrm{TNS\text{-}ASP} & \left[\begin{array}{ll} \mathrm{ASP} & \mathrm{perf} \\ \mathrm{TENSE} & \mathrm{pres} \end{array}\right]
\end{array}\right]$$

Restriction thus allows f-structures and predicates to be manipulated in a controlled and detailed fashion. Given an f-structure, the Restriction Operator can be applied to the current f-structure with respect to a certain feature in order to arrive at a restricted f-structure which does not contain that feature. The resulting f-structure is exactly the f-structure representation argued for from a theoretical perspective by Butt (1995) and Alsina (1996), even though no representation of a-structure has been integrated into the implementation. This is a nice result, which eases the tension between the computational and the theoretical perspectives.

Furthermore, the analysis of the permissive complex predicate uses restriction as part of the f-structure annotations on phrase structure rules. This means that there must be a c-structure node on which to put the restriction annotation that composes the valency of the verb and creates the final f-structure. Again, this mirrors Alsina’s and Butt’s arguments that the complex a-structure of a complex predicate which consists of two different lexical items (i.e., N-V, V-V) has to be put together in the syntax, not the lexicon.

4 Causatives: Theoretical vs. Computational Perspectives

One of the very interesting aspects of Alsina’s (1996, 1997) account of causatives is that he demonstrates that complex argument structure composition and the linking of thematic arguments to grammatical functions follows exactly the same analysis regardless of whether the complex predicate is formed syntactically, as in the French examples in (11), or morphologically, as in the Chicheŵa examples in (12). As can be seen, the two languages even show the same kind of semantic alternation with respect to causatives, even though one forms causatives morphologically, the other syntactically and even though the grammatical functions are realized quite differently in both of the languages.

(11) a. Jean a fait manger les gâteaux aux enfants.
Jean has made eat the cakes to the children
‘Jean made the children eat the cakes.’ French

b. Jean a fait manger les gâteaux par les enfants.
Jean has made eat the cakes by the children
‘Jean had the cakes eaten by the children.’ French

(12) a. Nŭngu i-na-phík-ítsa kadzīdzi maûngu
porcupine SUBJ-PAST-cook-CAUS owl pumpkins
'The porcupine made the owl cook the pumpkins.' Chicheŵa

b. Nŭngu i-na-phík-ítsa maûngu kwá kádzīdzi
porcupine SUBJ-PAST-cook-CAUS pumpkins by owl
'The porcupine had the pumpkins cooked by the owl.' Chicheŵa

The alternation illustrated in (12) and (13) as been analyzed in terms of *affectedness*, see Alsina (1996) for some discussion, as well as Saksena (1980), who analyzes a similar alternation in Hindi (illustrated in (18) and (19)). When the animate causee is the direct object in Bantu (placed right next to the verb), or marked with *a* 'to' in French, then the causee is taken to be also directly affected by the caused action, i.e., undergoes some change of state as well as being the agent that performs the caused action. In contrast, when the animate causee is marked by a 'by'-phrase, then the causee is just the agent/instrument by which the caused action took place, but no relevant change of state is assumed to have taken place.[7]

Important for the point of this paper is that causatives crosslinguistically display the same a-structure and semantic properties, regardless of whether they are expressed morphologically or syntactically. Within LFG, this is expected as morphology and syntax are treated as equals in terms of the information provided to the f-structure analysis of the clause. A sample a-structure analysis of both morphological and syntactic causatives is shown in (13) (essentially Alsina's 1996 analysis).

(13) $'\text{Cause} < \quad \text{ag} \quad \text{th} \quad '\text{pred}< \text{ag} \ldots >'>'$

$\quad\quad\quad\quad\quad\;$ SUBJ OBJ . . .

However, LFG's linking theory as originally formulated was situated squarely within the lexicon and so could deal easily with the complex a-structures of morphological causatives, but had to be modified in order to allow for the complex combination of a-structures within the syntax for syntactic causatives (Alsina 1996, Butt 1995, see the discussion in section 2).

From a computational linguistic perspective, *anything* involving complex argument composition is difficult. This is because information specified by the PRED is used to check Coherence and Completeness.

[7]This semantic distinction in terms of affectedness is one that should be explored more deeply from a semantic perspective, but this goes beyond the scope of our paper. That a difference in affectedness is involved seems to be an intuition that goes rather deep. Consider Speijer's (1886) description of a similar alternation between an accusative and an instrumental causee in Classical Sanskrit, illustrated here in (i) and (ii).

i. mantrapūtam carum **rājñīm** prāśayat
consecrated.Acc porridge.Acc queen.Sg.**Acc** eat.Caus.Impf.3.Sg
munisattamaḥ
best-of-ascetic.Nom
'the best of ascetics made the queen eat a consecrated porridge.'
(Kathaāsaritsāgar 9.10)

ii. tām **śvabhiḥ** khādayet rājā
Demon.F.Sg.Acc dog.Pl.**Inst** eat.Caus.Opt.3.Sg king.Nom
'Her the king should order to be devoured by dogs.'
(Mahābhārata 8.371)

> If one wants to say *he causes me to do something, it is by his impulse I act*, there is room for the type [accusative causee], but if it be meant *he gets soemthing done by me, I am only the agent or instrument through which he acts*, the instrumental is on its place. [Speijer (1886:§49)]

Thus, operations which change the information specified by the PRED are always difficult. There is, of course, a standard method of manipulating PRED values within LFG: Lexical Rules. Lexical rules are standardly used for simple argument deletions (passives) and renaming of grammatical functions (passives, dative shift), but our experiments with the grammar development platform XLE have shown that they are not powerful enough to deal with complex predication (which is expected, given the conclusion in Fn. 5 that complex predication and the simple addition/deletion of arguments are linguistically and formally quite different). Lexical rules provide ways of deleting, renaming, and adding simple arguments to a predicate, but not complex ways of merging them. Furthermore, even the addition of simple arguments to a predicate is complicated in that there must be a way of stating which argument slot is to be added and what happens to the existing arguments (for example, should the new argument be the first argument, thereby forcing all the other arguments one lower, or the last argument or the second?).

In light of the theoretical work showing the parallels between syntactic and morphological causatives, the question which arises with respect to the Restriction Operator is whether our proposals for syntactically formed complex predicates such as the Urdu permissive can also be applied to morphologically formed complex predicates, such as the Urdu causative. Morphological causatives are usually assumed to comprise a single lexical item and hence a single c-structure node. In the next section, we first present the basic data with respect to Urdu causatives and then show that our application of the Restriction Operator can be extended straightforwardly to morphological causatives. The key lies in the structure of the sublexical component and in the morphology-syntax interface assumed in the ParGram grammars.

That our analysis can be applied to both syntactic and morphological domains is encouraging, because our analysis remains true to Alsina's original insight that syntactically and morphologically formed complex predicates essentially work the same way with respect to complex predication. The difference between analyses like Alsina's and the one outlined here lies in the fact that the Restriction Operator analysis eschews any reference to a separate a-structure projection. Some consequences of the restriction analysis will be discussed in section 7.

5 The Urdu Causative and Restriction

As in the Chicheŵa examples in (12), Urdu causatives are formed morphologically by affixation. Unlike in Chicheŵa, in Urdu there are two different causatives: The -*vA* causative is usually associated with indirect causation, the -*A* causative with direct causation (Saksena 1982). In addition, there are two ways in which the causee can be realized. Some verb classes allow only an instrumental (=*sE*) causee, some only a dative/accusative one (=*kO*), and some both. The surface realization is determined by the "affectedness" of the causee (Saksena 1982, Butt 1998). In the next section, we first present some of the basic Urdu causative data and then show how our Restriction analysis applies to them.

5.1 The Urdu Causative Data

There are very few basic transitive verbs in Urdu. Most transitive verbs are causatives of intransitives. Both unergatives like 'laugh' in (14) and unaccusatives like 'burn' in (15) realize the causee as either a =*kO* marked accusative if the object is specific or unmarked nominative if the object is non-specific, as in the alternation in (15b).[8] Both of the examples are instances of the -*A* causative; using the -*vA* causative would indicate a more indirect causation.

[8]For details on the Urdu case marking system in general and the nominative/accusative alternation on objects in particular, see Butt and King (2005).

(14) a. yassIn has-A
Yassin.M.Nom laugh-Perf.M.Sg
'Yassin laughed.'

b. nAdyA=nE yassIn=kO has-**A**-yA
Nadya=Erg Yassin=Acc laugh-**Caus**-Perf.M.Sg
'Nadya made Yassin laugh.'

(15) a. jangal jal-A
jungle.M.Nom burn-Perf.M.Sg
'The jungle burned.'

b. fauj=nE jangal(=kO) jal-**A**-yA
army.F=Erg jungle.M.Nom(=Acc) burn-**Caus**-Perf.M.Sg
'The army burned (the) jungle.'

Example (16) shows the causativization of an agentive transitive.[9] Causativization of a typical agentive transitive licenses an instrumental causee, as shown in (16b). In contrast to the intransitive pattern in (14) and (15), a *kO* marked causee is ungrammtical.

(16) a. yassin=nE paodA kAT-A
Yassin=Erg plant.M.Nom cut-Perf.M.Sg
'Yassin cut the plant.'

b. nAdyA=nE yassIn=sE/*kO paoda kaT-**A**-yA
Nadya=Erg Yassin=Inst/Dat plant.M.Nom cut-**Caus**-Perf.M.Sg
'Nadya had the plant cut by Yassin.'

In Urdu, the case clitic *kO* functions both as an accusative and a dative (homophony). For an extensive discussion of the patterns and distribution see Butt and King (2005) and Mohanan (1994). With causatives, the distribution works as follows. When *kO* marks the only object in the clause, it functions as an accusative and participates in the specificity alternation, i.e., its realization is optional and marks specificity as in (15b). When there is another object in the clause, it marks an $\textsc{obj}_{th}$ and functions as a dative (i.e., it does not participate in the specificity alternation). Another way to tell the difference between accusative *kO* and dative *kO* is that accusatives can be passivized while datives cannot.

Not all transitives work as in (16). For example, with the class of *ingestive* verbs (e.g., *drink*, *eat*, *learn*, *read*) the agent is always seen as being affected by the action and so only a *kO* marked causee is allowed as in (17).

(17) a. yassin=nE kHAnA kHa-yA
Yassin=Erg food.Nom eat-Perf.M.Sg
'Yassin ate food.'

[9] As already mentioned, transitives are usually related to an intransitive verb root. In (16), the transitive *kAT* 'cut' is actually related to an intransitive verb root *kaT* 'be cut' via "vowel strengthening". The causativized version of (16a) is shown in (16b). As can be seen, the *-A/-vA* causative is added to the intransitive form of the root. The precise morphophonological factors involved in causation remain a subject of on-going investigation.

b. nAdyA=nE yassIn=kO/*sE kHAnA kHil-**A**-yA
Nadya=Erg Yassin=Dat/Inst food.Nom eat-**Caus**-Perf.M.Sg
‘Nadya had Yassin eat (fed Yassin).’

With some other verbs, both *kO* and *sE* marked causees are allowed. An example is shown in (18). (Other members of this class are *read, write, sing*.) These verbs allow a semantic alternation that is similar to the one discussed with respect to the French and Chicheŵa examples in (11) and (12). When the causee is marked with *kO*, the causee is interpreted as affected, as in (18); when the causee is instrumental, as in (19), it is interpreted as an agentive, non-affected causee.[10]

(18) anjum=nE saddaf=kO masAlA cakH-**vA**-yA
Anjum.F=Erg Saddaf.F=Dat spice.M.Nom taste-**Caus**-Perf.M.Sg
‘Anjum had Saddaf taste the seasoning.’

(19) anjum=nE saddaf=sE masAlA(=kO) cakH-**vA**-yA
Anjum.F=Erg Saddaf.F=Inst spice.M.Nom(=Acc) taste-**Caus**-Perf.M.Sg
‘Anjum had the seasoning tasted by Saddaf.’

The data introduced here cover the basic patterns found in Urdu. We have not discussed differences between *-A* and *-vA* causatives, which tend to signal “direct” vs. “indirect” causation, but the differences are subtle. Furthermore, not all verbs allow an *-A* causative and not all verbs allow a *-vA* causative. See Saksena (1982) and Butt (1998) for more details on patterns and analyses. However, these further complexities are not germane to the point addressed in this paper: can the Restriction Operator in principle be used to analyze morphological causation?

5.2 F-structures for Causatives

Let us take the most complex example in (18)–(19). The basic f-structure for the non-causative version (20a) is shown in (20b). The f-structures in (21) and (22) give the representations for the causatives in (18) and (19), respectively.

[10] A reviewer asks why one could not interpret ’Saddaf’ as causee in (16) (caused Saddaf to taste the seasoning), but the ’spice/seasoning’ as causee in (17) (caused the seasoning to be tasted by Saddaf). Indeed, this is exactly the analysis proposed by Alsina, as illustrated in (i) and (ii) for Chicheŵa (Alsina and Joshi 1991).

i, phik-itsa ‘cause’ $<$ ag pt ‘cook’$<$ ag pt $>>$ (OBJECT CAUSEE)
cook-CAUS

ii. phik-itsa ‘cause’ $<$ ag pt ‘cook’$<$ ag pt $>>$ (OBLIQUE CAUSEE)
cook-CAUS

This is a possible analysis, as is the idea coming out of Relational Grammar or Goverment-Binding that the oblique causee is derived by first demoting the embedded agent via passivization and then combining the argument structures (so that one gets an instrumental, oblique causee). The passivization idea is obviously not satisfactory, given that there is nothing passive about the causative. Alsina’s alternative in terms of Parameters on argument fusion raises the question if there are any constraints on argument fusion: can any thematic argument in the matrix a-structure potentially combine with any argument in the embedded a-structure? Observations about complex predicates crosslinguistically indicate that argument merger/fusion acts much like control: the lowest item in the matrix structure is generally identified with the highest argument of the embedded structure. If one adheres to this generalization, then the causee is always ’Saddaf’. Semantically, this would also seem to make more sense since it is difficult to act upon the seasoning to get the causaed action of ‘tasting’ done. See Butt (1998) for some more discussion.

(20) a. saddaf=nE masAlA cakH-A
Saddaf.F=Erg spice.M.Nom taste-Perf.M.Sg
'Saddaf tasted the seasoning.'

b. $$\left[\begin{array}{ll} \text{PRED} & \text{'taste<SUBJ, OBJ>'} \\ \text{SUBJ} & [\ \text{PRED 'Saddaf'}\ ] \\ \text{OBJ} & [\ \text{PRED 'seasoning'}\ ] \end{array}\right]$$

(21) $$\left[\begin{array}{ll} \text{PRED} & \text{'Cause<SUBJ, 'taste<OBJ-GO, OBJ>'>} \\ \text{SUBJ} & [\ \text{PRED 'Anjum'}\ ] \\ \text{OBJ-GO} & [\ \text{PRED 'Saddaf'}\ ] \\ \text{OBJ} & [\ \text{PRED 'seasoning'}\ ] \end{array}\right]$$

(22) $$\left[\begin{array}{ll} \text{PRED} & \text{'Cause<SUBJ, 'taste<OBL-AG, OBJ>'>} \\ \text{SUBJ} & [\ \text{PRED 'Anjum'}\ ] \\ \text{OBL-AG} & [\ \text{PRED 'Saddaf'}\ ] \\ \text{OBJ} & [\ \text{PRED 'seasoning'}\ ] \end{array}\right]$$

From the perspective of the Restriction Operator what is thus needed is something which "adds" a subject argument and "demotes" the argument of the main (embedded) verb to an OBL-AG, OBJ-GO or an OBJ in the case of intransitives, as illustrated in (23) and (24) for the examples in (14).

(23) $$\left[\begin{array}{ll} \text{PRED} & \text{'laugh<SUBJ>'} \\ \text{SUBJ} & [\ \text{PRED 'Yassin'}\ ] \end{array}\right]$$

(24) $$\left[\begin{array}{ll} \text{PRED} & \text{'Cause<SUBJ, 'laugh<OBJ>'>} \\ \text{SUBJ} & [\ \text{PRED 'Nadya'}\ ] \\ \text{OBJ} & [\ \text{PRED 'Yassin'}\ ] \end{array}\right]$$

So, in parallel to the analysis for the permissive, one would like to postulate a lexical entry like the one in (25) for the causative morphemes.

(25) $(\uparrow \text{PRED}) = \text{'Cause<}(\uparrow \text{SUBJ}), \%\text{PRED2>'}$

However, given that the causative morphemes are part of the morphology within the sublexical component, it may at first not be clear how this can be done (or whether this *should* be done). In the next section we therefore turn to a brief discussion of the morphology-syntax interface as implemented within the ParGram grammars and then show how the writing of lexical entries as in (25) is straightforward and unproblematic.

5.3 Causative Morphology and Morphology-Syntax Interface

Morphological analysis is integrated within the ParGram grammars via the finite-state methods described in Beesley and Karttunen (2003). In finite-state morphologies, morphemes are represented more or less abstractly (depending on the needs of the grammar)[11] and are arranged into finite-state continuation classes of the type shown in (26) for the Urdu verb *has* 'laugh'.

(26)
```
LEXICON Verbs
has+Verb:has          TnsAsp;

LEXICON TnsAsp
                      Imperfect;
                      Perfect;
                      Infinitive;

LEXICON Infinitive
+Inf:n                GendInf;

LEXICON GendInf
+Fem+Sg:I             #;
+Masc+Sg:A            #;
+Masc+Sg+Obl:E        #;
+Masc+Pl:E            #;
```

The extract from the finite-state morphology in (26) shows the association of morphemes with abstract "tags". The surface form *has* is associated with a stem *has* that is marked as being a verb (+Verb). The finite-state morphology specifies that verbs must have Tense/Aspect morphology, as indicated in the definition of Verbs which contains TnsAsp. This can take several forms, for example Imperfect, Perfect or Infinitive. In order to construct or parse an infinitive form such as *hasnE* we follow the continuation class that points to "Infinitive" through TnsAsp, where the infinitive marker *-n-* is found. This is associated with an abstact +Inf tag. From here the finite-state morphology points to the paradigm for gender and number marking that is appropriate for infinitives. As indicated by the *E* entries under GendInf, the form *hasnE* could be masculine singular oblique or it could be masculine plural.

The interface to the syntax makes use of the abstract tags associated with the surface morphemes (for more details, see Butt et al. (1999), Butt and Sadler (2003), Kaplan et al. (2004)). Essentially, the abstract tags are parsed via sublexical phrase structure rules. As part of this module, the abstract tags are also annotated with f-structure information, thus allowing information to flow into the syntactic analysis. As a concrete example, one of the possible sublexical trees for *hasnE* is shown in (27).[12]

(27)

V

$(\uparrow\mathrm{PRED})='\mathrm{has}\langle(\uparrow\mathrm{SUBJ})\rangle'$		$(\uparrow\mathrm{VFORM}) = \mathrm{inf}$	$(\uparrow\mathrm{GEND}) = \mathrm{masc}$	$(\uparrow\mathrm{NUM}) = \mathrm{pl}$
has	+Verb	+Inf	+Masc	+Pl

[11] In the Urdu grammar, we have so far represented the morphemes quite concretely. However, it is possible to posit more abstract representations in order to deal with allomorphy and phonological processes such as vowel harmony or assimilation. It is also possible to deal with complex morphology such as that of the Arabic templatic stem realization; see Beesley and Karttunen (2003) and Karttunen (2003) for an in-depth discussion.

[12] Note that Urdu allows subject, object and default (=no) agreement. Infinitives represent a special case because they agree only if they are acting as an object or a subject of a verb (analyzed as verbal nouns in this case, see Butt (1995) for a discussion). As such the agreement statements are quite complex and we have left them out of the representation in (27) for ease of exposition.

It should now be clear how the information necessary for a Restriction analysis can be associated straightforwardly with the causative morphology. The morphemes *-A* and *-vA* can be associated with an abstract +Caus tag. In the Urdu grammar, we have assigned the tags +Caus1 and +Caus2 to *-A* and *-vA*, respectively, in order to eventually be able to capture the differing semantic/pragmatic information associated with the two different morphemes.

The morphological analysis of the causativized perfect version of the verb *cakH* 'taste', for example, looks as in (28b,c) (cf. (18) and (19)).

(28) a. cakHA ⇔ cakH +Verb +Perf +Masc +Sg
b. cakHAyA ⇔ cakH +Verb +Caus1 +Perf +Masc +Sg
c. cakHvAyA ⇔ cakH +Verb +Caus2 +Perf +Masc +Sg

The lexical entry in (25) can now be associated with the +Caus tags, as shown in (29) for +Caus1.

(29) +Caus1 $(\uparrow \textsc{pred}) = {}'\text{Cause}\!<\!(\uparrow \textsc{subj}), \%\textsc{pred}2\!>\!{}'$

The lemma and morphological tags in (28) can now be parsed by sublexical c-structure rules (Kaplan et al. 2004), as illustrated in (27). The sublexical rules are formally identical to standard c-structure rules and hence can be annotated in the same way as more traditional c-structure rules, such as those used in the formation of the Urdu permissive.[13]

In the morphological causative, the +Caus tags thus provide a phrase-structure locus for the Restriction Operator. The causative annotated sublexical c-structure rule is shown in (30). This rule states that the main verb (↓) is identical to that of the causative verb (↑) except that the SUBJ and the original PRED are restricted out ($\downarrow\backslash\textsc{subj}\backslash\textsc{pred}{=}\uparrow\backslash\textsc{subj}\backslash\textsc{pred}$). The subject of the main verb is identified with the OBJ-GO, OBJ, or OBL of the causative verb ($(\downarrow\textsc{subj}){=}\ \{\ (\uparrow\textsc{obj-go})\ |\ (\uparrow\textsc{obj})\ |\ (\uparrow\textsc{obl})\ \}$). Which of these grammatical functions is chosen will depend on the affectedness of the causee, the type of causative, and the lexical semantics of the main verb.[14] Finally, the PRED of the main verb is assigned to the second argument of the causative predicate ($(\uparrow \textsc{pred arg}2){=}(\downarrow \textsc{pred})$), just as was done for the permissive.

(30)
$$
\begin{array}{lcc}
\text{V} \rightarrow & \text{Vstem} & \text{CauseMorph} \\
& \downarrow\backslash\textsc{subj}\backslash\textsc{pred}{=}\uparrow\backslash\textsc{subj}\backslash\textsc{pred} & \uparrow{=}\downarrow \\
& (\downarrow\textsc{subj}){=}\ \{\ (\uparrow\textsc{obj-go}) & \\
& \quad |\ (\uparrow\textsc{obj}) & \\
& \quad |\ (\uparrow\textsc{obl})\ \} & \\
& (\uparrow \textsc{pred arg}2){=}(\downarrow \textsc{pred}) &
\end{array}
$$

The restriction analysis thus treats morphologically and syntactically formed complex predicates the same, as was the case in Alsina's (1997) analysis. In addition, the morphology-syntax interface is well-understood and cleanly formulated.[15] In the next section, we further explore the effects of our analysis

[13]These rules do not violate lexical integrity since they are located in the sublexical domain. The sublexical rules shown in (27) are flat. However, if it proved necessary, one could have a more configurational sublexical tree (i.e., to indicate hierarchical relations between morphemes).

[14]In the current implementation, simple lexical semantics such as unaccusative vs. unergative verbs are encoded in f-structure (they could also be encoded at s(emantic)-structure, but the current implementation does not include this extra projection). The causative rule can then refer to this feature.

[15]Karttunen (2003) shows that Realizational Morphology (Stump 2001), which has been extensively argued to be suitable for LFG (LFG02 workshop on morphology, Sadler and Spencer 2005) is finite-state equivalent.

by examining interactions between morphologically and syntactically formed complex predicates and periphrastic passives.

6 Interactions with the Restriction Analysis of Causatives

Urdu allows productive interactions between different types of complex predicates and between complex predicates and passives. In this section, we first look at some of the interactions between different types of complex predicates (permissives and causatives) in order to see whether the application of the Restriction Operator in different parts of the grammar (syntax and morphology) causes problems. As section 6.1 shows, this interaction works robustly and causes no problems whatsoever. In section 6.2 we examine the interaction between the Restriction Operator and lexical rules by looking at passive causatives.

6.1 Interaction of Causatives and Complex Predicates

One syntactically formed complex predicate can interact with another one, as illustrated by (31) in which the causative version of 'laugh' acts as the main verb in a permissive complex predicate. The f-structure representation of (31) is shown in (32).

(31) anjum nE nAdyA kO yassIn kO has-A-n-E dI-yA
Anjum=Erg Nadya=Dat Yassin=Acc laugh-Caus-Inf-Obl give-Perf.M.Sg
'Anjum let Nadya make Yassin laugh.'

(32) $\begin{bmatrix} \textsc{pred} & \text{'give<}\textsc{subj}\text{, 'Cause<}\textsc{obj-go}\text{,'laugh<}\textsc{obj}\text{>'>'>'} \\ \textsc{subj} & [\ \textsc{pred}\ \text{'Hassan'}\ ] \\ \textsc{obj-go} & [\ \textsc{pred}\ \text{'Nadya'}\ ] \\ \textsc{obj} & [\ \textsc{pred}\ \text{'Yassin'}\ ] \end{bmatrix}$

In this case, one complex PRED is built within the morphological component, namely the combination of *Cause* and *has* 'laugh'. This combination results in the complex PRED'Cause<SUBJ,'laugh<OBJ>'>', which is then further combined with the permissive light verb *dE* 'give' to yield the PRED shown in (32). This interaction between Restriction Operators situated in different parts of the grammar is completely unproblematic.

6.2 Interaction of Causative and Passive

Next we consider the interaction of passive with the causative. In the Urdu ParGram grammar, passives are treated via a standard passive lexical rule by which the active subject is identified as the passive OBL-AG and the active object is identified as the passive SUBJ. This passive lexical rule is triggered by a periphrastic construction formed with an auxiliary based on the verb 'go'. The main verb must carry " perfect" morphology. An example of a passive causative is shown in (33b). Note that the causative applies first, creating a transitive verb from the intransitive *has* 'laugh', and then the passive applies.

(33) a. nAdyA=nE yassIn=kO has-A-yA
Nadya=Erg Yassin=Acc laugh-Caus-Perf.M.Sg
'Nadya made Yassin laugh.'

b. yassIn (nAdyA=sE) has-A-ya ga-yA
Yassin.Nom Nadya=Inst laugh-Caus-Perf.M.Sg go-Perf.M.Sg
‘Yassin was made to laugh (by Nadya).’

The f-structure representation for (33a) is shown in (34). The complex PRED is a combination of the main verb *has* ‘laugh’ and the causative. The f-structure representation for (33b) is shown in (34b). In (34b) the causative verb undergoes passive just as an underlyingly transitive verb would have.

(34) a. Causative:

$$\begin{bmatrix} \text{PRED} & '\text{Cause}<\text{SUBJ},'\text{laugh}<\text{OBJ}>'>' \\ \text{SUBJ} & [\ \text{PRED}\ '\text{Nadya}'\ ] \\ \text{OBJ} & [\ \text{PRED}\ '\text{Yassin}'\ ] \end{bmatrix}$$

b. Causative + Passive:

$$\begin{bmatrix} \text{PRED} & '\text{Cause}<\text{OBL-AG},'\text{laugh}<\text{SUBJ}>'>' \\ \text{OBL-AG} & [\ \text{PRED}\ '\text{Nadya}'\ ] \\ \text{SUBJ} & [\ \text{PRED}\ '\text{Yassin}'\ ] \\ \text{PASSIVE} & + \end{bmatrix}$$

From a theoretical standpoint, applying the lexical rule based passive to the causative is straightforward. However, implementing this interaction using a combination of the restriction operator on the sublexical rules for the causative and a lexical rule for the passive proved to be more challenging and highlights some interesting issues that would otherwise have remained unexplored. For example, at one stage in the development of the Urdu grammar, in the analysis for (33b), the subject of the causative had been correctly realized as the OBL-AG but the object had not been realized as the SUBJ in the final, restricted f-structure. This type of structure results from not sufficiently constraining the lexical rules to apply only to the final, non-restricted structure. This is particularly apparent in that there was no subject for the final f-structure. Although Urdu obeys the Subject Condition, the XLE implementation of LFG does not universally impose a Subject Condition in order to allow for languages which have truly subjectless constructions (see Babby (1993) on Russian adversity impersonals). The subjectless structures incorrectly obtained for Urdu during the development of the causative analysis highlight the need to carefully state the Subject Condition and its interaction with the Restriction Operator in such a way as to avoid producing subjectless constructions from ones with subjects.

Currently, we are trying to fully understand the interaction between lexical rules and the Restriction Operator. We are exploring whether this is a grammar engineering issue in the sense that we have not found a robust enough statement of the interaction, or whether this is a fundamental implementational and theoretical issue in that the formal underpinnings of the interaction between restriction and lexical rules need to be better understood and reimplemented. Understanding the interaction is not trivial because the Restriction Operator is a very complex and powerful method of manipulating PRED values. Because of the possibility of building complex PREDs via the Restriction Operator, the checks for Completeness, Coherence and the Subject Condition have to be done differently. Indeed, Alsina (1996) addresses this issue at length from an a-structure perspective. Alsina has to address this issue because his (and Butt’s 1995) analysis of complex predicates assumed a complicated projection architecture involving a-structure. Interestingly, it seems that even when an overt use of a-structure representations is avoided, i.e., by allowing a composition of PRED values directly within the f-structure, deep architectural questions arise. This is because the essential problem to do with complex predication, the composition of PREDs, has not gone away: it has simply been moved to a different part of the grammar.

7 Conclusions: Morphology and LFG Architecture

This paper has discussed different methods of dealing with complex predication by looking at the interaction between morphologically and syntactically formed complex predicates and passives. We have shown that complex morphological valency changing operations such as the morphological causative can be analyzed using the Restriction Operator. This allows for the seamless integration of the causatives with complex valency changing operations in Urdu that are situated in the syntax. The key to the formal integration of this analysis is the interaction of the morphology with the syntax, in particular in the domain of the annotated phrase-structure rules.

However, while the Restriction Operator allows the formation of complex PREDs in just the way that Alsina's (1996), Butt's (1995) and Mohanan's (1994) analyses suggest is needed for complex predication, it also raises some further theoretical and implementational issues. Beyond the issue of how to check for Coherence, Completeness and the Subject Condition, questions about the status of the Principle of Direct Syntactic Encoding are also raised.[16] That is, one of the principles of LFG was to avoid the overly powerful transformation architecture of Transformational Grammar (and its successors) and to not allow for the change of grammatical functions in the syntax (lexical rules operate on lexical representations).

The introduction of the Restriction Operator as first proposed by Kaplan and Wedekind (1993) respected this principle: the Restriction Operator was only applied within the lexical domain. However, as Butt (1994) showed, this domain of application could not do justice to the syntactically productive nature of complex predicate formation. With Butt, King and Maxwell's (2003) application of the Restriction Operator within the syntax, violations of the Principle of Direct Syntactic Encoding become eminently possible.

The advantage of the a-structure approach therefore seems to be that it assembles pieces of the complex predicate at the level of a-structure and only maps this information to f-structure in a very last step, thus avoiding the direct manipulation of grammatical functions. From a computational point of view, however, this means that precise well-formedness conditions for a-structure must be formulated and implemented. It is not the case that all a-structures can be combined in any kind of manner: a-structure composition is governed by strict constraints. However, our theoretical understanding of these constraints remains limited and therefore the computational rendering of them is next to impossible. In addition, some well-formedness checks, like Coherence and Completeness, have to be performed both at f-structure and at a-structure, thus duplicating the efforts at well-formedness checking (see also Dalrymple (2001) on how glue semantics accounts for completeness and coherence). Alsina (1996) therefore proposes to abandon checking at f-structure and to perform well-formedness checks only at a-structure (see also Alsina, Mohanan and Mohanan (2005) for a discussion along these lines).

The crux of the matter is therefore how to deal with complex valency changing phenomena that go beyond the simple addition (applicatives), deletion (passives) or renaming (dative shift) of arguments/grammatical functions. The proper treatment of derivational morphology within LFG is a related issue. As with valency changing phenomena, the metaphors linguists use when talking about derivational morphology are very naturally ones in which some original information (e.g., the lexical information associated with a verb) is changed into some other kind of information via the addition of derivational morphology (e.g., a nominalizer like -*ion*). Again, these are transformational metaphors and given the close interaction between

[16]We would like to thank Joan Bresnan for pointing this out and engaging in on-going discussions on this issue with us.

derivational morphology and syntactic encoding, some of the same issues arise as with complex predicates.

Here we see the integration of finite-state morphologies into LFG grammars as an advantage. Conceptually, the finite-state approach provides a clean and well-defined interface to larger grammatical processes. However, little has been done until now to model a theoretically interesting approach to derivational morphology within the LFG grammars (note that Stump's (2001) theory of morphology, which has been advocated for adoption within LFG, is confined to inflectional morphology). As morphological causatives represent a type of derivational morphology, we feel that this paper is taking a first step in that direction and is already uncovering interesting architectural issues. In particular, it seems crucial to us that any further exploration of these issues take into account both theoretical and computational perspectives.

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