

On the Semantics of Hindi-Urdu Multiple Correlatives†

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Dayal (1995, 1996) argues that Hindi-Urdu (HU) correlatives are internally-headed free relatives left-adjoined to a clause that contains a demonstrative matching the head of the relative in number. Following Jacobson's (1995) analysis of free relatives, Dayal argues that the correlatives are interpreted as definite descriptions. In the case of correlatives, the definite does not occupy an argument position but, from its adjoined position, binds a variable introduced by its matching demonstrative. (PR = present tense)

- (1) a. jo laRkii khaRii hai vo lambii hai
which girl standing be-PR she tall be-PR
'The girl who is standing is tall' (Dayal 1996, p.160)

When the internal head is singular, the correlative is interpreted as a singular definite description. When the internal head is plural, the correlative is interpreted as a plural definite, receiving either a distributive (2a) or a collective reading (2b).

- (2) a. jo laRkiyaaN khaRii haiN ve lambii haiN
which girls standing be-PR they tall be-PR
'The girls who are standing are tall' (Dayal 1996, p.12)
- b. jo laRkiyaaN khaRii haiN ve bahane haiN
which girls standing be-PR they sisters be-PR
'The girls who are standing are sisters' (Dayal 1996, p.193)

In addition to these simple cases, HU allows the typologically rare multiple correlative. A multiple correlative contains more than one relative operator each of which must be matched by an agreeing demonstrative element in the clause to which the correlative is adjoined. Consider the multiple correlative in (3).

- (3) [jis laRkii-ne jis laRke-ke saath khelaa] us-ne us-ko haraayaa
which girl-erg which boy-with play she-erg he-acc defeated
'Which girl played with which boy, she defeated him'

Interestingly, though both heads are singular, the correlative need not refer to a single girl-boy pair, but may instead quantify universally over multiple girl-boy pairs. So, multiple correlatives have universal force (UF). There are two restrictions, however, on when such universal quantification over boy-girl pairs can take place felicitously. The first, the Exhaustion Requirement (ER), is that there must be a pair in the set for every member of the thematically/hierarchically higher head. In this case, for example, every girl must have played a boy. The second, the Uniqueness Requirement (UR), is that there can be no more than one pair for each member of the higher head. So, in this case, no girl can have played more than one boy. The three components of the meaning of (3) are summarized in (4).

- (4) (ER) Every girl played a boy
(UR) No girl played more than one boy
(UF) Every girl beat the boy she played

The purpose of this squib is to examine Dayal's 1996 influential account of the semantics of multiple correlatives and demonstrate that it can be simplified. Dayal stipulates ER, UR and UF in the lexical entry of the complementizer of multiple correlatives. I suggest that each of these can be derived from independent principles of grammar.

1. Dayal's Analysis

As stated above, Dayal analyzes correlatives as free relatives and follows Jacobson in assigning correlatives the semantics of definite descriptions. Unlike Jacobson, Dayal suggests that the definite determiner is contributed by the complementizer of the free relative.¹

- (5) a. [which girl₁ [C_{corr} [t₁ is standing]]]₂ [she₂ is tall]
 $\lambda y. \text{girl}'(y) \quad \lambda x. \text{standing}'(x) \quad \lambda z. \text{tall}'(z)$
- b. $[[C_{\text{corr}}]] = \lambda X. \lambda Y. \lambda Z. Z[\sigma x(X(x) \ \& \ Y(x))]$

To handle the case of multiple correlatives, Dayal suggests a generalization of the definite determiner denoted by the correlative complementizer to take multiple heads.

- (6) $\lambda X. \lambda Y. \lambda Z. \lambda R. \exists f^{\circ} [f^{\circ} = \text{uf} [\text{dom } f = Y \ \& \ \forall y [Z(f(y))] \ \& \ \forall z \in Y \ X(z)(f)]]$
 $\ \& \ \forall x \in Y \ R(x, f^{\circ}(x))]$

(7) Dayal's LF of (3)

$$\begin{array}{cccc} [\text{rel boy}_2 [\text{rel girl}_1 [C [t_1 \text{ played } t_2^1]]]] [t_1 \text{ beat } t_2] \\ \uparrow \quad \quad \uparrow \quad \quad \uparrow \quad \quad \uparrow \\ Z \quad \quad Y \quad \quad X \quad \quad R \end{array}$$

(8) $[[t_1 \text{ played } t_2^1]] = \lambda x. \lambda f. x \text{ played with } f(x)$

UF follows from the last conjunct of (6). ER follows from setting the domain of f to Y . UR follows from the uniqueness of f : if X related a member of Y to two members of Z , f would not be unique. I contend that none of this stipulation is necessary – that these aspects of the meaning can be derived with a more Jacobsonian analysis of free relatives along with natural principles of type-shifting and presupposition projection.

2. Jacobson 1995

Jacobson suggests that free relatives become individual denoting expressions in two steps. As is standard, relativization produces a predicate of individuals. In the first step of Jacobson's analysis, the predicate is maximalized due to the semantics of the relative operator, see (10). That is, the relative operator maps a predicate to a predicate that is true of exactly one individual. In the second step, this predicate may or may not be shifted from this singleton set to its member (Partee's 1987 iota shift). If not shifted it may serve as a predicate. If shifted, it may serve as an argument.

- (9) a. This is what Bill sent you. (Predicate)
b. What Bill sent you is on the table. (Argument)

(10) $\llbracket \text{what} \rrbracket = \lambda P. \lambda x. P(x) \ \& \ \forall y (P(y) \rightarrow y \leq x)$

I suggest that to derive the semantics of a multiple correlative we need to keep these two steps separate. Specifically, I suggest that predicate maximalization is applied twice in multiple correlatives – once for each relative operator. This will yield UR. The iota shift, on the other hand, will only apply once – at the top node of the correlative.

3. Proposal

I assume then, that the correlative complementizer makes no contribution to the semantics of multiple correlatives. Instead, I assume the structure (11) for the LF of (3).

(11) $[_{CP2} [\text{which girl}] \ 1[_{CP1} [\text{which boy}] \ 2[\ C \ [_{IP} \ t_1 \ \text{played} \ t_2]]]]]$

A few comments are in order on the differences between my LF and Dayal's. I assume that the order of the relative operators in CP at LF reflects the order of their base positions. Concretely, I assume the the subject *which girl* moves to CP at LF first, followed by the object tucking-in underneath it. Furthermore, unlike Dayal I do not assume the trace of the object bears a complex index requiring abstraction over a function variable. Instead, I assume the moved object binds an individual variable. Onto the interpretation.

Let's work our way up this structure slowly. First, the constituent that is sister to *which boy* denotes a predicate of type $\langle e, t \rangle$. (Assume the variable assignment under which the structure is being interpreted is g .)

(12) $\lambda x. g(1) \text{ played } x$

Contra Jacobson, I assume that the relative operator *which* is semantically vacuous. Thus I assume that the relative head, in this case *boy*, combines directly with (12) by Predicate Modification, yielding (13).

(13) $\lambda x. x \text{ is a boy } \& g(1) \text{ played } x$

Though semantically vacuous, the relative operator triggers the application of Maximalization to the first CP node dominating it. So at this stage, the operator MAX (14) applies to the predicate in (13).²

(14) $MAX = \lambda f: \exists! x[x \in f \& \forall y \in f[y \leq x]]. \lambda z. z = \sigma_x(x \in f \& \forall y \in f[y \leq x])$

(15) $MAX(\lambda x. x \text{ is a boy } \& g(1) \text{ played } x) =$

$\lambda x. x \text{ is the unique boy } g(1) \text{ played}$

Given (14) and the singularity of *boy*, the semantic value of CP1 in (11) is only defined under an assignment g if there is a unique boy that $g(1)$ played. When defined CP1 denotes (15). If this were a single correlative we would apply the iota shift at this point.

However, since this is a multiple correlative we cannot apply the iota shift as this would result in uninterpretability when we later attempt to use Predicate Modification to compose *girl* with its sister.

Instead we proceed by applying Predicate Abstraction again, now with index 1. Now that a presupposition has been introduced we must be explicit about the rules of projection: note the definedness conditions imposed by (16). This gives us (17) as the denotation of the sister of *which girl*.

(16) Predicate Abstraction

If α is a branching node whose daughters are β and an index i , then

$$\llbracket \alpha \rrbracket^g = \lambda x: \beta \in \text{dom } \llbracket \cdot \rrbracket^{g[x/i]}. \llbracket \beta \rrbracket^{g[x/i]} \quad (\text{Heim \& Kratzer 1998})$$

(17) λy : there is a unique boy that y played. λx . x is the unique boy y played

At the next higher node the two-place predicate in (17) must compose with the one-place predicate denoted by *girl*. I propose that the grammar permits the latter to restrict the first coordinate of the former by an extension of predicate modification. (Cp. Restriction of Chung and Ladusaw 2004).

(18) Predicate Modification

If α is a branching node whose daughters are β and γ , where $\llbracket \beta \rrbracket \in D_{\langle e, t \rangle}$ and $\llbracket \gamma \rrbracket \in D_{\langle e, T \rangle}$, where T is a conjoinable type, then

$$\llbracket \alpha \rrbracket = \lambda x. \lambda y. \dots \lambda z. \llbracket \beta \rrbracket (x) = 1 \ \& \ \llbracket \gamma \rrbracket (x)(y) \dots (z) = 1$$

Notice that if we had applied the iota shift to CP1, we could not have applied Predicate Modification at this node; CP1 would not have denoted a conjoinable type.

Now we must pay special attention to how the presupposition introduced by the lower MAX is projected. The rule in (18) does not specifically address projection. I suggest following Heim's (1983) analysis of presupposition projection in quantified structures. Under this approach, the presupposition ($\pi(x_i)$ in (19)) of the relative clause (RC) projects as a universal presupposition about the domain of the nominal head (N).

$$(19) \quad [[DP \text{ Det}_i [N(x_i) \ \& \ RC(x_i)_{\pi(x_i)}]] VP] \text{ presupposes } \forall x [N(x) \rightarrow \pi(x)]$$

E.g. \llbracket [no man who brought his son] VP \rrbracket presupposes every man has a son.

$$(20) \quad \llbracket CP2 \rrbracket \text{ is defined only if every girl played a unique boy}$$

$$(21) \quad \text{If defined, } \llbracket CP2 \rrbracket =$$

$$\lambda y. \lambda x. y \text{ is girl and } x \text{ is the unique boy } y \text{ played}$$

Notice what we have now: the left-to-right Schönfinkelized characteristic function of a function from girls to the boy that they played. (21) characterizes a *function* thanks to the presupposition of the lower MAX which constrains each girl to be paired with one and only one boy. This is the basis for our derivation of UR. Furthermore, the presupposition introduced by relativization guarantees that every member of the higher

domain (*girl*) is matched to some member of the lower domain (*boy*). This is the basis for our derivation of ER. Now we must lay the foundation for the derivation of UF.

We need to combine the function (21) with the main clause. Following Dayal 1996, I assume the main clause denotes a two-place predicate, each demonstrative introducing a variable that has been abstracted over. I suggest that the semantic composition of the correlative and main clauses can happen in two ways. First, maximalization – generalized to two-place predicates – alone may apply to the correlative. Alternatively, the maximalization of the correlative may be preceded by the application of Link’s pluralization operator * – also generalized to two place predicates. This is why we must separate MAX from abstraction – to allow an intervening *.

$$(22) \quad \llbracket \text{she}_1 \text{ beat him}_2 \rrbracket = \lambda x. \lambda y. x \text{ beat } y \quad (\text{see Dayal 1996})$$

Crucial to this analysis is the generalization of the maximalization and pluralization operations to two-place predicates. First, I assume the pluralization operator * treats a predicate of type $\langle e, \langle e, t \rangle \rangle$ as a set of ordered pairs, returning a set of sets of ordered pairs as its output.

$$(23) \quad *[\lambda x. \lambda y. x \text{ played } y] = (*\{ \langle x, y \rangle : x \text{ played } y \} =) \\ \lambda S. S \subseteq \{ \langle x, y \rangle : x \text{ played } y \} \ \& \ S \neq \emptyset$$

I assume that MAX also treats $\langle e, \langle e, t \rangle \rangle$ predicates as sets of ordered pairs. Following Sharvy 1980, if MAX applies to a set of ordered pairs it is defined only if the set contains exactly one ordered pair. In that case, it picks out the singleton containing that ordered pair as its reference. On the other hand, if MAX applies to a set of sets of ordered pairs it picks out the singleton containing the maximal set as its reference.

$$(24) \quad \text{MAX} = \lambda S: \exists! x[x \in S \ \& \ \forall y \in S[y \leq x]]. \lambda z. z = \sigma x(x \in S \ \& \ \forall y \in S[y \leq x])$$

Suppose then that we apply our generalized MAX operator to the function that we derived in (21). If that function only truly applies to one pair of individuals then, it will denote the singleton set containing that pair. The iota shift then applies to this set yielding the pair by itself. The two-place function denoted by the main clause then applies to this pair (cf. (25)), yielding a truth value. In this way, we obtain a single-pair reading (Dayal 1996, p.204).

(25) 2-place Function Application

If α is a branching node whose daughters are β and γ , where $\llbracket \beta \rrbracket \in D_{\langle e, \langle e, t \rangle \rangle}$ and $\llbracket \gamma \rrbracket = \langle a, b \rangle$, where $a, b \in D_e$, $\llbracket \alpha \rrbracket = \llbracket \beta \rrbracket(a)(b)$

Suppose on the other hand, that we apply the pluralization operator * to our function in (21). Then, before maximalization, we obtain a set of sets of ordered pairs. When maximalization applies to this set, the output is the singleton containing the maximal set of ordered pairs. Assuming that maximalization preserves the ER presupposition

associated with the function in (21), this output set must contain one girl-boy pair for every girl in the domain, if it is defined.

$$(26) \quad *[\lambda y. \lambda x. y \text{ is a girl and } x \text{ is the unique boy } y \text{ played}] = \\ \{S: S \subseteq \{\langle x, v \rangle: x \text{ is a girl and } y \text{ is the unique boy } x \text{ played with}\}\}$$

$$(27) \quad \text{MAX}((26)) = \lambda S. S = \{\langle x, v \rangle: x \text{ is a girl and } y \text{ is the unique boy } x \text{ played with}\}$$

The iota shift then applies to (27), yielding the single set that verifies it. This set can combine with the predicate denoted by the main clause, as long as that predicate also undergoes pluralization, cf. (29). This gives us the equivalent of universal quantification over boy-girl pairs (UF), along with the appropriate restrictions UR and ER.³ I leave it to the reader to see this analysis extends beyond two relative operators.

(28) The final structure for multiple correlatives:

$$[\iota [\text{MAX} [* [\text{which girl } 1 [\text{MAX} [\text{which boy } 2 [t_1 \text{ played } t_2]]]]]]]] \\ [* 1 2 [t_1 \text{ beat } t_2]]$$

$$(29) \quad *[\lambda x. \lambda y. x \text{ beat } y] = \\ \lambda S. S \subseteq \{\langle x, y \rangle: x \text{ beat } y\} \ \& \ S \neq \emptyset$$

$$(30) \quad \llbracket (28) \rrbracket \text{ is defined iff every girl played exactly one boy} \\ \llbracket (28) \rrbracket = 1 \text{ iff for every pair of a girl } x \text{ and the unique boy } y \text{ that } x \text{ played, } x \text{ beat } y$$

4. Comments on the application of *

Application of pluralization to CP2 is crucial to our calculation. One question that arises about this application is the following: why not **?

- (31) **R is the smallest relation R' such that : (i) $R \subseteq R'$ and
(ii) if $\langle u, y \rangle \in R'$ and $\langle x, z \rangle \in R'$, then $\langle u+x, y+z \rangle \in R'$

The predicate to which we applied * is two-place. A natural alternative to pluralization would have been the double star ** (31, Krifka 1986). Application of ** would sever the anaphoric connection between who each girl plays and who she beats in (3). To fully motivate our calculation, then, it is necessary to find a principle that rules out ** as an option at this node. At this point, I am not aware of such a principle.

Another question is why pluralization can apply at all at this node and not at other lower nodes. Here I think we stand on firmer ground. We may assume that * may apply at any node, though at certain nodes it must be matched by appropriate plural morphology on nominals. Our application of * is felicitous with singular relative heads because it yields a reading distinct from any reading in which its application is replaced by the pluralization of the nominal heads. For example, applying * to CP1 in (11) would have the same effect as pluralizing *boy*. So, such application is forbidden – blocked by overt plural marking.

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¹ I substitute English words for their HU counterparts in the calculation for ease of exposition.

² I switch freely between set-talk and function-talk to make definitions more perspicuous.

³ An anonymous reviewer's intuition is that ER and UR are defeasible. For us, ER is a presupposition. There are two ways in which it might seem defeated: (i) presupposition cancellation and (ii) domain restriction. UR is enforced by the requirement that each relative head be matched to a local MAX. If both relative heads could instead be matched to the higher MAX in (28) – and the lower MAX omitted – UR would go away.