A Performance Based Approach to Multiple Dependencies

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Abstract

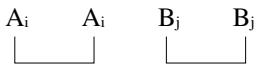
Some multiple dependencies are consistent with performance preferences, while others are not. Among the latter are crossed dependencies which manifest (i) the order preservation effect in leftward multiple dependency, and (ii) the increasing weight effect in rightward multiple dependency. In this paper, I argue that these inconsistent patterns are phonological in nature and motivated by PF-side performance considerations, which is in conformity with the minimalist ideas that seek to find ultimate and external explanations for the linguistic cognitive system.*

1. Constraints on Multiple Dependencies: A General Picture

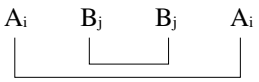
The term "dependency" in this paper refers to the relation between a displaced element and its related (and co-indexed) counterpart although it does not matter for the present purpose whether they are transformationally related or not. Three types of multiple dependencies, (i) disjoint, (ii) nested or embedded, and (iii) crossed, are illustrated in (1).

(1) Three patterns of multiple dependencies

i. Disjoint



ii. Nested (or embedded)



iii. Crossed

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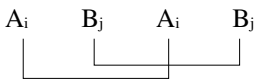


In psycholinguistic literature, it has been noted that performance (processing or production) preferences are (i) > (= 'preferred over') (ii) > (iii). First, disjoint dependency is preferred over nested dependency, or simply nested dependency leads to processing difficulty (e.g. Bach, Brown, and Marslen-Wilson 1986, Pickering and Barry 1991, Karlsson 2007). Secondly, nested dependency is preferred over crossed dependency (e.g. Fodor 1978, Rochemont and Culicover 1990, and Pickering and Barry 1991).

Examples of leftward multiple dependency (LMD) are shown below. Those in (2)-(4) are consistent with the alleged performance preferences. The sentences in (2) and (3) involve wh-movement and *tough*-movement, and the two dependencies must be nested as in (a), and not crossed as in (b). Also in multiple wh-movement, the two dependencies should be nested as in (4a), and not crossed as in (4b).

(2) a. What$_i$ are boxes$_j$ easy to store _$_j$ in _$_i$?
b. *What$_i$ are boxes$_j$ easy to store _$_i$ in _$_j$? (Fodor 1978:448)

(3) a. [Which violin]$_i$ is [this sonata]$_j$ easy to play _$_j$ on _$_i$?
b. *[Which sonata]$_i$ is [this violin]$_j$ easy to play _$_i$ on _$_j$? (Fodor 1978:450)

(4) a. ?[Which girl]$_i$ did you ask the secretary [who]$_j$ Bill had written to _$_j$ about _$_i$?
b. *[Which girl]$_i$ did you ask the secretary [who]$_j$ Bill had written to _$_i$ about _$_j$?
(Fodor 1978:451)

On the other hand, some cases of LMD are not consistent with the performance preferences. For example, we find nested dependencies everywhere in the grammar where phrase structures are recursive as in (5) (Chomsky 1957, 1965, 2007:5, Partee et al. 1993:477-480, as cited in Karlsson 2007). In fact, recursivity is considered to be a core part of human language faculty (e.g. Chomsky 2007).

(5) The rat$_j$ [the cat$_i$ [the dog chased _$_i$] killed _$_j$] ate the malt.

Furthermore, crossed dependencies are abundant in object shift, the effect of which has been captured in terms of Holmberg's Generalization that object shift is contingent on verb movement.

(6) Swedish

a. Jag [kysste]$_v$ [henne]$_o$ inte _$_v$ _$_o$?
I kissed her not
'I did not kiss her'

b. att jag inte kysste henne
that I not kissed her

c. *att jag [henne]$_o$ inte kysste _$_o$ (Fox and Pesetsky 2005a:17)

(7) Danish

a. Peter [viste]$_v$ [hende]$_i$ [den]$_j$ jo _$_v$ _$_i$ _$_j$.
Peter showed her it indeed
'Peter indeed showed it to her'

b. *Peter [viste]$_v$ [den]$_i$ [hende]$_j$ jo _$_v$ _$_j$ _$_i$. (Müller 2005:163, 2006:6)

In contrast to (4) above, some cases of multiple wh-movement require crossed dependency, and the nested alternative leads to a wh-island violation or a superiority effect.

(8) a. ?I wonder [what]$_i$ you forgot [from whom]$_j$ you got _$_i$ _$_j$?

b. *I wonder [from whom]$_i$ you forgot [what]$_j$ you got _$_j$ _$_i$?(Reinhart 2006:32)

(9) Bulgarian

a. [Koj]$_s$ [kogo]$_o$ _$_s$ vižda _$_o$?
who whom sees

b. *[Kogo]$_o$ [koj]$_s$ _$_s$ vižda _$_o$?
'Who sees whom?'

Turning to rightward multiple dependency (RMD), again we find the cases that are consistent with performance preferences, as well as the cases that are not. In general, multiple occurrences of extraposition from NP (EXNP) and heavy NP shift (HNPS) prefer nested dependency over crossed dependency, as shown in (10)-(12).

(10) a. No one _$_s$ puts things _$_o$ in the sink [that would block it]$_o$ [who wants to go on being a friend of mine]$_s$.

b. *No one _$_s$ puts things _$_o$ in the sink [who wants to go on being a friend of mine]$_s$ [that would block it]$_o$. (Fodor 1978:452)

(11) a. I gave _$_i$ _$_j$ today [to a policeman]$_j$ [an extremely pretty flower]$_i$.
> (= 'better than') (Sabbagh 2007:395)

b. I gave $\__i$ $\__j$ today [an extremely pretty flower]$_i$ [to a policeman]$_j$.
(Chris Tancredi p.c.)

(12) a. Sue gave $\__i$ $\__j$ on Friday [to the student who works on Parasitic Gaps]$_j$ [the book about HNPS]$_i$. (Chris Tancredi p.c.)

>

b. *Sue gave $\__i$ $\__j$ on Friday [the book about HNPS]$_i$ [to the student who works on Parasitic Gaps]$_j$. (Takahashi 2004)

However, crossed dependency is not totally excluded as is shown in (13) and (14) below. In these examples, the rightmost element is relatively heavier than the previous one, exhibiting an increasing weight effect.

(13) Someone $\__s$ ate beans $\__o$ yesterday [who was tired]$_s$ [that should have been cooked thoroughly before anyone even considered eating them]$_o$. (Frazier and Clifton 1996:102)

(14) I gave $\__i$ $\__j$ today [an extremely pretty flower]$_i$ [to a policeman who always smiled at me when I passed by his police box and captured my heart]$_j$.
(> (11b)) (Chris Tancredi p.c.)

The table in (15) summarizes LMD and RMD examples in terms of the consistency with performance preferences.

(15) Multiple dependency (MD) and its consistency with performance preferences

	Leftward MD	Rightward MD
Consistent: nested dependency	- wh- +*tough*-movement(2)(3) - multiple wh-movement (4)	- multiple EXNP (10) - multiple HNPS (11)(12)
*In*consistent: Holmberg's Generalization superiority increasing weight	- object shift (6)(7) - multiple wh-movement (8)(9)	- multiple EXNP (13) - multiple HNPS (14)

In the following sections, I will discuss some previous analyses of these MD examples and

attempt to provide a unified account of the inconsistent patterns in terms of their PF-interface properties.

2. Previous Analyses of Constraints on Multiple Dependency

The cases that are consistent with performance preferences have been naturally given performance based accounts. Fodor's (1978) Nested Dependency Constraint (NDC) is an example.

(16) Nested Dependency Constraint (NDC) (Fodor 1978:448)
If there are two or more filler-gap dependencies in the same sentence, their scopes may not intersect if either disjoint or nested dependencies are compatible with the well-formedness conditions of the language.

Fodor argues that the NDC is a non-ambiguity constraint, which grammaticalizes parsing strategies.
That is to say, if a single string of words allows two different dependency relations, nested and crossed (e.g. (2)-(4)), the NDC chooses the former, and rules out the latter as ungrammatical. Rochemont and Culicover (1990) later propose Interpretive Nesting Requirement (INR), which applies to choose between two alternative strings of words, especially in RMD cases (e.g. (10)-(12)). The NDC and the INR are considered to be LF conditions since they are concerned with the semantic scope of dependencies.

Turning to inconsistent cases, different analyses are given to different types of MDs. For example, Fox and Pesetsky (2005a) propose Order Preservation (OP) in (17) to explain the constraints on object shift.

(17) Order Preservation (OP) (Fox and Pesetsky 2005a:6)
Information about linearization, once established at the end of a given Spell-out domain, is never deleted in the course of a derivation. (Spell-out domain (= phases) = CP, VP)

They assume multiple spell-out, and OP is a restriction on linearization process, which acts as a filter on derivations (Fox and Pesetsky 2005a,b). To take (6) for example (repeated below), the verb – object order in the VP domain shown in (6b) needs to be preserved at the higher CP domain where they get spelled out. Therefore, the object *henne* cannot shift independently of verb-movement as in (6c).

(6) Swedish

a. Jag [kysste]$_v$ [henne]$_o$ inte _$_v$ _$_o$?
I kissed her not

b. att jag inte kysste henne
that I not kissed her

c. *att jag [henne]$_o$ inte kysste _$_o$ (Fox and Pesetsky 2005a:17)

Superiority is captured in terms of the closeness condition on movement, for example, Attract in (18). Attract is a syntactic operation which accommodates the notion of closeness.

(18) Attract (Chomsky 1995:297)
K *attracts* F if F is the closest feature that can enter into a checking relation with a sublabel of K.

To take (8) for example (repeated below), movement in (8b) does not satisfy Attract because the relevant feature in the higher [Spec, CP] attracts the wh-phrase *from whom* although the wh-phrase *what* is higher and hence closer.

(8) a. ?I wonder [what]$_i$ you forgot [from whom]$_j$ you got _$_i$ _$_j$?
b. *I wonder [from whom]$_i$ you forgot [what]$_j$ you got _$_j$ _$_i$?(Reinhart 2006:32)

As for inconsistent RMD cases, Hawkins proposes the principle of Minimize Domain (MiD), which grammaticalizes parsing strategies as the NDC does (Hawkins 1994, 2004).

(19) Minimize Domain (MiD) (Hawkins 2004:31)
The human processor prefers to minimize the connected sequences of linguistic forms and their conventionally associated syntactic and semantic properties in which relations of combination and/or dependency are processed.

To illustrate how MiD works, let us compare heavy NP shift examples in (11) and (14) (repeated below).

(11) a. I gave _$_i$ _$_j$ today [to a policeman]$_j$ [an extremely pretty flower]$_i$.
> (= 'better than') (Sabbagh 2007:395)

b. I gave _$_i$ _$_j$ today [an extremely pretty flower]$_i$ [to a policeman]$_j$.

(Chris Tancredi p.c.)

(14) I gave $\__i$ $\__j$ today [an extremely pretty flower]$_i$ [to a policeman who always smiled at me when I passed by his police box and captured my heart]$_j$.
(> (11b)) (Chris Tancredi, p.c.)

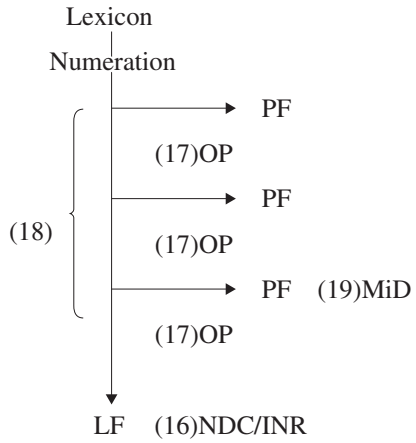
In heavy NP shift, the relevant domain is VP, and the MiD principle prefers a lighter object being placed before a heavier object in order to process the syntactic and semantic properties of the elements of VP as soon as possible. In (11) and (14), the relevant elements are the verb *give*, the direct object NP, and the indirect object PP. MiD's requirements can be contradictory with the performance preferences, and in (14), the lighter direct object precedes the heavier indirect object, resulting in the crossed dependency. In this example, the processor needs to process from the verb up to the preposition *to* in order to know what the VP consists of, and because the heavy PP is placed at the sentence-final position, the time of processing the VP is faster than that when the heavy PP intervenes between the verb and the direct object NP (*I gave today [to a policeman who always smiled at me when I passed by his police box and captured my heart][an extremely pretty flower]*). Thus, MiD counts the number of words to minimize the relevant domain, and I consider it to be a principle that applies at the PF-interface.

Below is the summary of previous accounts of constraints on MDs, and where in the grammar they are supposed to apply illustrated in (21).

(20) Previous accounts of multiple dependency (MD)

	Leftward MD	Rightward MD
Consistent	(16) Nested Dependency Constraint (NDC) (Interpretive Nesting Requirement (INR))	
*In*consistent	(17) Order Preservation (OP) (18) Attract	(19) Minimize Domain (MiD)

(21)　Types of constraints



Having seen this, the next question is whether we can unify the inconsistent cases and give them a unified account. This is what I will do in the next section.

3. Toward an Explanation of Inconsistent Patterns: An PF-Interface Approach

A research question I would like to ask at this point is: How many of the inconsistent patterns can be attributed to general interface conditions, and how many of purely formal constraints still need to be stipulated. Let us start with further investigation on rightward multiple dependency (RMD) cases.

3.1. Rightward Multiple Dependency is Governed by Processing Efficiency

Remember that consistent RMD cases are accounted for in terms of Nested Dependency Constraint (NDC) defined as in (16) above, and in inconsistent RMD cases, the Minimize Domain (MiD) principle (19) overrides the NDC, resulting in the increasing weight effect. Since both NDC and MiD are grammatical principles motivated by processing efficiency, we can regard the RMD patterns are uniformly governed by performance considerations, e.g. ease of syntactic and semantic processing. The NDC results from the general parsing strategy whereas the MiD works only when one of the relevant constituents is heavy enough to achieve increasing weight.[1] The MiD may override the NDC.

3.2. Leftward Multiple Dependency is Governed by Production Efficiency

As is with RMD cases, consistent cases of leftward multiple dependency (LMD) are accounted for in terms of Nested Dependency Constraint. In these cases, Order Preservation (OP) in (17) and Attract (18) do not seem to be in effect for some reason. On the other hand, inconsistent LMD cases, whether object shift or multiple wh-movement, exhibit the order preservation effect. Thus, LMD cases have not been given a unified account so far, and reconsideration of previous analyses of LMD is in order.

I would like to start with pointing out problems with OP. A key assumption for OP to account for Holmberg's Generalization is that object shift, unlike wh-movement, does not proceed successive cyclically. The flip side of this is that OP cannot account for the order preservation effect in multiple wh-movement, which may apply to wh-phrases in whichever order (resulting in either nested or crossed dependency) as long as they are within the same spell-out domain, e.g. VP.

(22) Problems with Order Preservation (OP) (Fox and Pesetsky 2005a,b, Müller 2005,2006)
LMD:
a. object shift: [$\boxed{\text{CP}}$ S V [$_{\text{TP}}$ $\__s$ O adv [$\boxed{\text{VP}}$ $\__v$ $\__o$]]] ($\square$ = Spell-out domains)
b. Multiple wh-movement: … [$\boxed{\text{VP}}$ wh_i wh_j V $\__i$ $\__j$] or … [$\boxed{\text{VP}}$ wh_i wh_j V $\__j$ $\__i$]

In other words, OP is irrelevant to phase-internal operations (Fox and Pesetsky 2005b:258).

Furthermore, OP should not be able to account for the weight effect in multiple extraposition from NP either (though it could account for the weight effect in multiple heavy NP shift assuming that rightward movement does not proceed successive cyclically, e.g. Ross 1967, Akmajian 1975).

(23) Problems with Order Preservation (OP)
RMD:
Multiple extraposition from NP:
[$\boxed{\text{CP}}$[$_{\text{TP}}$ S $\__s$ [$\boxed{\text{VP}}$ V O $\__o$] adv] EX_o EX_s] or [$\boxed{\text{CP}}$[$_{\text{TP}}$ S $\__s$ [$\boxed{\text{VP}}$ V O $\__o$] adv] EX_s EX_o]

Like multiple wh-movement, extraposition from NP may move a phrase extraposed from object (EX_o) and a phrase extraposed from subject (EX_s) in either the nested or the crossed order as long as they are within the same spell-out domain, i.e. CP. Note that only EX_o originates within VP and the issue of the word order between EX_o and EX_s does not arise in this domain.

Let us turn to the problems with Attract. Attract, defined in (18), only concerns relevant features, and hence cannot account for the observed generalization that *any phonologically visible category* inside VP preceding the object will block object shift (Holmberg 1998). That is to say, it does not extend to apply to the order preservation effect in object shift.

Regarding the research question of whether we can provide a unified account of inconsistent LMD cases, I argue that they are the results of phonological operations, and also subject to PF-interface conditions. First, following the insight of Erteschik-Shir (2005), I argue that object shift is a result of phonologically motivated linearization involving Prosodic Incorporation (PI), which is motivated by production efficiency. For example, in (6) (repeated below), the verb and the object are incorporated into a prosodic unit V+O, and in (7) (repeated below), the verb, the indirect object, and the direct object are incorporated into a prosodic unit V+IO+DO, and hence they need to move together without changing word order. The PI occurs for ease of pronunciation.

(6) Swedish

a. Jag [kysste]$_v$ [henne]$_o$ inte _$_v$ _$_o$?
I kissed her not

b. att jag inte kysste henne
that I not kissed her

c. *att jag [henne]$_o$ inte kysste _$_o$ (Fox and Pesetsky 2005a:17)

(7) Danish

a. Peter [viste]$_v$ [hende]$_i$ [den]$_j$ jo _$_v$ _$_i$ _$_j$.
Peter showed her it indeed

b. *Peter [viste]$_v$ [den]$_i$ [hende]$_j$ jo _$_v$ _$_j$ _$_i$. (Müller 2005:163, 2006:6)

According to this prosodic approach to object shift, it is predicted that “language variation will often depend on *language particular constraints on PI*, such as which constitute types can provide hosts and which elements must PI” (Erteschik-Shir 2005:66-67, italics are mine). This prediction is borne out by the following examples.

(24) Swedish

Henne visar jag den helst inte
her show I it rather not
‘I’d rather not show it to HER’ (Erteschik-Shir 2005:62)

(25) Icelandic

a. Jón las bókina + ekki.
   Joh read the.books not
b. Jón las ekki + bókina. (Erteschik-Shir 2005:78)
c. Ég sá+ekki [ráðherrann sem allir eru að kvarta yfir].
   I saw+not minister.the who all are to complain over
   'I didn't see the minister who everyone was complaining about'
d. ??Ég sá [ráðherrann sem allir eru að kvarta yfir] ekki. (Erteschik-Shir 2005:79)

In the Swedish object shift example (24), the indirect object is shifted before the verb. Crucially, the indirect object is focused and prosodically strong in this case. The prosodically strong pronoun does not incorporate into the verb and hence may move independently, violating Order Preservation. This indicates that Order Preservation should not be a rigid grammatical principle and is violable for prosodic reasons. The Prosodic Incorporation is regarded as a prosodic operation motivated by ease of pronunciation.

In the Icelandic object shift example (25), the light object *bókina* may shift with the verb whereas the heavy object, *ráðherrann sem allir eru að kvarta yfir*, does not. Thus, the weight of the object matters for the application of object shift, and this suggests that a prosodically based approach to object shift should be in order.

Turning to multiple wh-movement, Erteschik-Shir (2005) suggests it is also a result of phonologically motivated linearization:

> "In cases of multiple wh-phrases, some languages front only the first one. […] the fronted wh-phrase functions as a topic whereas the others are focused and are therefore independently highlighted. It follows that they need not front. Other languages require the fronting of all wh-phrases, or leave them all in situ. It would be interesting to explore whether the wh-parameter results from different *phonological* 'high-lighting' mechanisms across languages."
>
> (Erteschik-Shir 2005:89, italics are mine.)

It is also worth noting here that D-linked wh-phrases do not always exhibit the order preservation effect, as shown in (26)-(28).

(26) a. Who bought what?
b. *[What]$_o$ did [who]$_s$ ($\_s$) buy $\_o$?
c. *Mary asked [what]$_o$ [who]$_s$ ($\_s$) read $\_o$.

d. Mary asked [which book]$_o$ [which man]$_s$ ($\__s$) read $\__o$.

(27) a. *I wonder [which person]$_s$ you forget [which talk]$_o$ $\__s$ gave $\__o$ at the workshop.

b. I wonder [which talk]$_o$ you forget [which person]$_s$ ($\__s$) gave $\__o$ at the workshop.

(28) a. *I wonder [which person]$_s$ you forget [at which workshop]$_{loc}$ $\__s$ gave a talk $\__{loc}$.

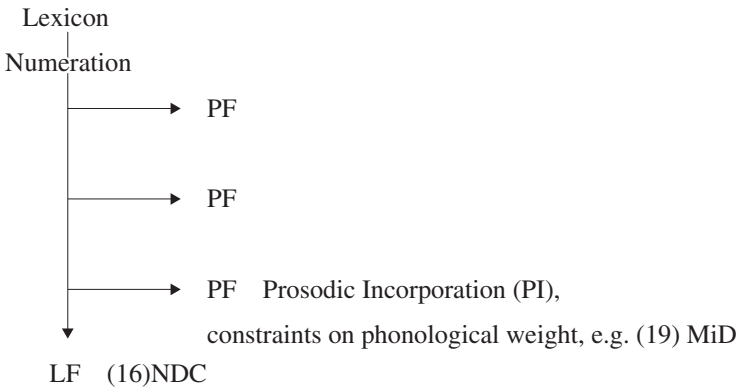
b. ?I wonder [at which workshop]$_{loc}$ you forget [which person]$_s$ ($\__s$) gave a talk $\__{loc}$.

The grammaticality of (26d), (27b) and (28b) provides another piece of evidence that the order preservation effect in multiple wh-movement is not a rigid one. However, I leave for future work the investigation of exactly what kind of phonological constraint explains grammatical and ungrammatical multiple wh-movement.

3.3. Summary: Multiple Dependency is Governed by Performance Efficiency

Below is a summary of the constraints discussed in this section and where in the grammar they apply:

(29) Types of constraints (compare with (21))



We saw that (i) the multiple dependency that is consistent with performance preferences is accounted for by Nested Dependency Constraint (NDC) applying at LF; (ii) the inconsistent rightward multiple dependency exhibits increasing weight and is captured by Minimize Domain (MiD) applying at PF; and (iii) the inconsistent leftward multiple dependency, in particular object shift examples, is given a phonological account in terms of Prosodic Incorporation (PI). More generally, I argue that possible and impossible multiple dependency is determined by performance efficiency. In particular, the consistent multiple dependency and inconsistent rightward multiple dependency are governed by processing efficiency, whereas the inconsistent

leftward multiple dependency is governed by performance efficiency, e.g. ease of pronunciation. The performance based approach to multiple dependency is based on the minimalist ideas that seek to find ultimate and external explanations for the linguistic cognitive system (Chomsky 1995 and subsequent work).

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1）See Shiobara (2001) for discussion on how to measure weight, and Hawkins (1994, 2004) and Shiobara (2004, 2007) for weight effects in general.