

# **HOW HAS OPTIMALITY THEORY ACHIEVED THE GOALS OF LINGUISTIC THEORY**

**Prof. Nidham Sheet Hameed(PhD)**

**English Department, College of Arts, University of Baghdad**

**drnidham2000@ yahoo.com**

**Lect. Israa B. Abdurrahman(M.A)**

**English Department, College of Education for Women, Tikrit University**

**awabsayed@yahoo.com**

## **Abstract**

Optimality Theory (OT) is a grammatical framework of recent origin presented by Prince and Smolensky in 1993. The central idea of Optimality Theory is that surface forms of language reflect resolutions of conflicts between competing *constraints*. A surface form is ‘optimal’ in the sense that it incurs the least serious violations of a set of violable constraints, ranked in a language-specific hierarchy. Constraints are universal and languages differ in the ranking of constraints, giving priorities to some constraints over others. Such rankings are based on ‘strict’ domination: if one constraint outranks another, the higher-ranked constraint has priority, regardless of violations of the lower-ranked one. However, such violation must be minimal, which predicts the *economy* property of grammatical processes. This paper tries to seek the clues to prove that optimality theory achieves the goals of linguistic theory successfully.

## 1. The Foundations of Optimality Theory

In the early 1991, Alan Prince and Paul Smolensky began preparing their work for a new approach to language. By 1993, they developed a new theory known as *Optimality theory* (OT henceforth) (Hess, 2005: 5). OT first became widely known through Paul and Smolensky's 1993 manuscript Optimality Theory: Constraint Interaction and Generative Grammar. The theory was first applied to phonology and its impact on this field was extensive and immediate for it quickly attracted many researchers like Ito (1993), McCarthy & Prince (1993), McCarthy (1993) and was later used by a growing number of phonologists like McCarthy (2001) who surveys advanced topics, Kager (2004) who presents an entry-level introduction to OT, and the Rutgers Optimality Archive (<http://ruccs.rutgers.edu/roa.html>) which contains hundreds of OT papers. Ever since its introduction to phonology by Prince and Smolensky (1993), Optimality Theory (OT) has attracted linguists not only in phonology, but also in syntax, and lately also in semantics and pragmatics.

## 2. The Components of Optimality Theory

According to Prince & Smolensky (2004: 5), OT comprises three components, namely, The Generator (**GEN** henceforth), The Constraints (**CON** henceforth), and The Evaluator (**EVAL** henceforth). These components constitute the whole architecture of OT. GEN is a method for generating a potentially infinite set of candidate representations, CON is a set of universal, violable, constraints in a strict dominance hierarchy, and EVAL is a method for determining the relative harmony of the candidates based on the constraint hierarchy. Given an input representation and a constraint hierarchy, GEN and EVAL work to find the most harmonic, or optimal, output representation.

## 2.1 Generator

Paul & Smolensky (2004: 5) declare that Gen is a *universal* candidate generator. It has two closely related functions:

- a. It constructs candidate output forms, such as words or sentences.
- b. It specifies a relation between the candidate output forms and the input.

McCarthy & Prince (1994: 4) state that GEN is a function that tries to define for each possible input the range of candidate linguistic analyses available to that input. McCarthy (2007: 308) & (2008: 16) states that GEN in OT is equivalent to the transformational component in GP in the sense that it generates a list of possible outputs for a given input. To justify this one can conclude that the transformational component and GEN both function as mediators between the underlying and the surface structures. Furthermore, Oostendorp & Hermans (1999: 3) state that in OT a minimal derivational residue persists: there is a function mapping inputs to outputs. McCarthy (2010: 1), in addition to that, assures that OT does have an operational component that is GEN; the role of this component is to take an underlying representation and *transform* it into a set of candidate output forms. In other words, GEN enumerates the range of alternative input-output pairs, from which the optimal or best one must be selected by a grammar. McCarthy (2003: 4) assumes that, "if grammar is optimization, and optimization is choice, then grammar must explicitly define for each possible input, exactly what its possible alternative outputs are". The generated set of the collection of alternatives is called the **candidate set**.

Based on McCarthy (2008: 16), the relationship among the input, GEN, and the candidate set can be diagrammed as follows forming a partial flowchart for OT:

(1) Partial flowchart for OT

/input/     $\longrightarrow$     GEN     $\longrightarrow$     {cand1, cand2, ..., candn }

The details of the input and GEN depend on whether we are analyzing phonology, syntax, or semantics. In phonology, the input in the underlying representation is that, for instance, every morpheme that alternates regularly has a unique form. In the example (based on McCarthy, 2008: 16), the plural */-z/* in */bæg-z/*, */bʊk-z/*, and */no:z-z/* (bags, books, and noses) has a unique morpheme that alternates regularly as just shown. Here comes the role of operational GEN to perform various operations on the input: GEN will delete segments, epenthesize them, and change their feature values consequently. According to Paul & Smolensky (2004: 7) these operations are applied freely, optionally, and repeatedly in order to derive the members of the candidate set. For example, the candidate set from the input */set-z/* will include results of progressive and regressive voice assimilation ([sets], [sedz]), epenthesis ([setə z]), deletion ([set]), and various combinations of these processes ([setə s]). It will also include a faithful candidate where nothing has happened: ([setz]). These various candidates, nearly all of which are ungrammatical, are not to be regarded the final output of the grammar; the final output is decided after the candidate set is filtered by the constraint component. Later, the candidates [sets], [sedz], [setə z], [set], [setə s], etc., compete to be the surface realization of the input [set-z]. Other candidates that belong to other inputs do not participate in this competition for there is no comparison of the

mapping /set-z/ [sets] with the mapping /dres-z/ [dresə z]. Accordingly, we can say that GEN has a function of defining the range of competitors for a given input. McCarthy (2008: 17) clarifies that "this range must include at least all of the ways that the input could be realized in any possible human language".

## 2.2 Constraints

Optimality Theory, which according to Archangeli (1997: 1) is '...the Linguistic Theory of the 1990s', adopts a radically different approach from The Generative Phonology: it focuses on constraining possible surface representations rather than rules. In fact, in what we might call the standard version of Optimality Theory (Prince and Smolensky 1993), rules are excluded from the phonology in favor of constraints, and formal superiority is therefore claimed for OT since only a single type of formal object is involved (McMahon, 2000: 6).

The central idea of OT is to give up the inviolability of constraints and to consider a set of violable constraints CON. Furthermore, a strict ranking relation  $\_$  is defined on *Con*. This relation makes it possible to evaluate the candidate structural descriptions in terms of the totality of the violations they commit, as determined by the ranking of the constraints.

If one constraint C1 outranks certain constraints C2,..., Cn, written  $C1\_ \{C2, \dots, Cn\}$ , then *one* violation of C1 counts more than as arbitrarily many violations of C2, ..., Cn. The evaluation component later selects the optimal (least offending, most harmonic) candidate(s) from the set *Gen*. The grammar favors the competitor that best satisfies the constraints. Only an optimal output is taken as an appropriate (grammatical) output; all 'suboptimal' outputs are taken as ungrammatical. This idea makes the

grammaticality of a linguistic object dependent on the existence of a competitor that better satisfies the constraints (McCarthy, 2008: 13).

There are two basic types of constraints. **Faithfulness constraints** require that the observed surface form (the output) matches the underlying or lexical form (the input) in some particular way; that is, these constraints require identity between input and output forms. **Markedness constraints** impose requirements on the structural well-formedness of the output (Blutner, et al, 2004: 4). Each plays a crucial role in the theory. Faithfulness constraints prevent every input from being realized as some unmarked form, and markedness constraints motivate changes from the underlying form.

The Constraint Set, according to the theory (Prince & Smolensky, 2004: 6), is a set of universal constraints shared by all languages. Languages differ not by the constraints themselves but by the ranking of the constraints. This implies that the constraints are hierarchically ordered, and in a relation of strict dominance. Contrary to other generative theories, violation of a constraint need not be fatal, but may be necessary in order to satisfy a higher-ranked constraint.

The universal nature of CON makes some immediate predictions about language typology. If grammars differ only by having different rankings of CON, then the set of possible human languages is determined by the constraints that exist. Optimality theory, as Fichtner (2005: 13) affirms, predicts that there cannot be more grammars than there are alternatives of the ranking of CON. The number of possible rankings is equal to the factorial of the total number of constraints, thus giving rise to the term *Factorial Typology*. However, it may not be possible to distinguish all of

these potential grammars, since not every constraint is guaranteed to have an observable effect in every language. Two languages could generate the same range of input-output mappings, but differ in the relative ranking of two constraints which do not conflict with each other (Fichtner, 2005: 13).

### 2.3 Evaluator

Gen produces a candidate set from an input, and that candidate set is submitted to OT's other main component, the *Evaluator*. Below is the complete OT flowchart through which it is obvious that Eval's job is to find the *optimal* candidate. Eval does this by applying a language-particular constraint hierarchy to the set of candidates:


$/input/ \rightarrow \text{Gen} \rightarrow \{cand1, cand2, \dots\} \rightarrow \text{Eval} \rightarrow [output]$
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**Flowchart for OT** (following McCarthy 2008: 19)


To return to a point made earlier, Eval never looks for candidates that *obey* a constraint; it only asks for candidates that *are most favored by* a constraint. Being favored by a constraint isn't the same as obeying it. One or more candidates are always favored, but it will sometimes happen that no candidate obeys a given constraint. As a result, there is always some optimal candidate.

### 3. The Tableau

The ranking of constraints can be demonstrated by a tableau: this lists two (or any number of) output candidates vertically in random order, and constraints horizontally, in a descending ranking from left to right. The cells contain violation marks '\*' incurred by each candidate for the constraint heading the column. Schematically:

	C1	C2
a.  Candidate a		*
b. Candidate b	*!	

#### A tableau for simple domination

The optimal candidate is marked by the index ''. This candidate is (a), which has no violations of the higher-ranked constraint *C1*, a constraint violated by its competitor (b). Note that the optimal candidate (a) is actually not impeccable itself: it has a violation of *C2*, but this flaw is insignificant to the outcome. Although the pattern of violations for *C2* is the reverse of that for *C1*, this does not help candidate b. Its violation of *C1* is already fatal, indicated by the accompanying exclamation mark '!' and the shading of cells whose violation content is no longer relevant. In sum, candidate (a) is optimal as *no candidate* is available that fares better, satisfying *both constraints* at the same time. A violation of *C2* is taken for granted, as long as *C1* can be satisfied [for more clarification see McCarthy & Prince (1993: 7-9), Kager (2004: 13)].

#### **4. The Principles of Optimality Theory**

Optimality Theory is a development of Generative Grammar, a theory sharing its focus on formal description and quest for universal principles, on the basis of empirical research of linguistic typology and (first) language acquisition. However, OT radically differs from earlier generative models in various ways. OT is often claimed to be a revolutionary new way of dealing with phonological problems, and has largely replaced rule-based frameworks. Its main assumption is that the observed forms of language arise from the interaction between conflicting constraints. OT theory



models grammars as systems that provide mappings from inputs to outputs, typically the inputs are conceived of as underlying representations and the outputs as their surface realizations (McCarthy, 2005: 170) & (McCarthy, 2006: ). OT's mechanism is based on some fundamental principles that are listed briefly below [following Prince & Smolensky (1993), McCarthy & Prince (1993) and Kager (2004)]:

**Universality:** constraints are universal. This implies that all constraints are part of the grammars of all natural languages. This is not to say that every constraint will be equally active in all languages. Due to the language-specific ranking of constraints, a constraint that is never violated in one language may be violated but still be active in a second language, and be totally inactive in yet a third language.

**Violability:** constraints are violable, but violation must be minimal. No constraint is violated without a convincing reason: avoiding the violation of another higher-ranked constraint. When a constraint is violated, violation must be kept to a minimum. Forms with 'lesser' violations are more harmonic than forms with 'greater' violations. Violability of constraints is an essential property of OT, representing a radical break away from derivational models in which rules must be obeyed strictly.

**Optimality:** an output is 'optimal' when it incurs the least serious violations of a set of constraints, taking into account their hierarchical ranking. So we assume that each output form of the grammar is by definition the 'best possible' in terms of the *hierarchy* of constraints, rather than the form which matches all constraints at the same time. 'Perfect' output forms are principally non-existent, as every output form will violate

at least some constraints. Therefore, the selection of the ‘optimal’ output form involves setting priorities.

**Domination:** the higher-ranked of a pair of conflicting constraints takes precedence over the lower-ranked one.

**Fallacy of perfection:** no output form is possible that satisfies all constraints. An output is ‘optimal’ since there is no such thing as a ‘perfect’ output: all that grammars may accomplish is to select the most harmonic output, the one which incurs the minimal violation of constraints, taking into account their ranking.

**Parallelism:** all constraints related to some type of structure interact in a single hierarchy. It is parallelism which predicts that faithfulness constraints may interact with markedness constraints in a single hierarchy. But at a higher level of sophistication, parallelism is also the basis of explanation of phenomena involving ‘interface’ properties.

## 5. The Goals of Linguistic Theory

By describing natural languages, it is obvious that there are many differences among them. These differences are not only among genetically unrelated languages like English and Arabic which are very dissimilar, but also among languages that have similar origin like Arabic and Hebrew which differ from each other in many important aspects (Ruhlen, 1987:91). However, one can also find some similarities among languages. On the other hand, although languages may differ from each other, the range of variation among them is not unlimited (Shaumyan, 1982: 7). These aspects are considered to be the main concern of a linguistic theory.

While it might be impossible to determine the set of goals for linguistic theory which every linguist would agree with, it is however possible to draw a list of general goals which linguists would be consensus upon. The majority of linguists, such as Shaumyan (1982:8), Valin and Lapolla (1997:3-8), and Kager(2004:1), agree that linguistic theory must achieve the following goals:

**5.1 Universality.** To shed light on the core of grammatical principles that is common to all languages is regarded to be the main concern of linguistic theory. It is assumed that grammars of individual languages draw their basic options from a limited set of universal properties. This set is identified by linguists as **Universal Grammar**. According to this assumption, linguistic theory must state linguistic universals, i.e., provide linguistic principles that are considered true of the grammar of every possible natural language. Kager (2004: 1) suggests that this assumption is based on evidence that adheres with two domains: **Language typology** and **language acquisition**. Concerning the first domain, linguistic theory must be able to state the principles of possible variations among languages, i.e., the principles that depict the interrelation of language types. The second piece of evidence for universality emerges from the universal patterns of language acquisition. Children, while acquiring their first language, pass through developmental stages using remarkably similar ways. It is hypothesized that: what makes grammars so much alike in their basic design is the innateness of Universal Grammar; it is the same reason that causes the observed developmental similarities (Johansson, 1991: 4).

**5.2 Description of linguistic phenomena.** Describing linguistic phenomena is one of the central goals in linguistics. This may include describing individual languages, describing what is common to all

languages or describing how languages differ from each other. Van Valin and Lapolla (1997: 2) state that linguistic description is necessary for two reasons. Firstly, language is an important aspect of our common human heritage, besides that languages vanish as their last speakers die, or they are replaced by 'socioculturally dominant' languages. Hence, description is important for the preservation of knowledge of the variety of human languages in the face of extinction or change. Secondly, to develop explanatory theories of languages is impossible without descriptions of linguistic phenomena. Hence, we cannot explain linguistic phenomena unless it is first described, i.e., description is the basis of later explanations and theories.

**5.3 Explanation of linguistic phenomena.** According to Chomsky (1957: 49-57), the main role of linguistic theory is to "provide criteria for selecting the most explanatory grammar from among a group of competing grammars". He further suggests a list of general topics for what a linguistic theory should explain:

- a. How languages change over time<sup>1</sup>;
- b. How speakers use language in different social situations;
- c. How children acquire and learn language.

**5.4 Understanding the cognitive basis of language.** Linguistic theory must provide conceptual and formal tools for constructing explanatory grammars that enable us to deal with three major facets of the psychology of language:

- a. Acquisition. How do human beings come to have knowledge of language?
- b. How our knowledge is organized and represented?

- c. Processing. What cognitive processes are involved when human beings produce and understand languages.

## 6. Conclusion

It is a fact that any new theory puts old questions into a new light. However, to achieve the goals of linguistic theory is what a linguistic theory should concern itself with whatever field it tackles.

Optimality theory is a modern linguistic theory that aims at describing and explaining languages in a new framework. It is considered to be a radical departure from the derivational model of the previous versions of generative phonology. It assumes that grammars of individual languages draw their basic options from a set of universal constraints. It achieved **universality** by the ranking and the reranking of such constraints. These constraints are considered to be a detailed **description** of linguistic phenomenon in different languages.

As for the **explanation** for such phenomena, optimality theory tries to provide an efficient justification for the occurrence of different phenomena basing its principles on the connectionist model as a **cognitive** psychological theory. It also provides a good model for the explanation of language acquisition and language change.

It can be said, accordingly, that optimality theory can provide a comprehensive account of any linguistic phenomenon: It tries successfully to achieve the goals of linguistic theory.

## Notes

1. Kenstowicz and Kisseberth (1979: 251) suggest that any adequate theory of phonology must contain postulates that will define natural sound changes. Although many of these can be expressed by appeal to the notion of assimilation defined over the features of a feature system, it is clear that not all natural sound changes fit into this mold. For example, many languages have a rule converting consonants to  $\text{ʔ}$  or  $h$  in preconsonantal and final position. Such a process is clearly not assimilatory in nature. Nevertheless phonological theory must have some apparatus for expressing the fact that neutralization to a glottal stop in these positions is a natural rule as opposed to, say, neutralization to  $/l/$ .

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## كيف حققت نظرية الأفضلية أهداف النظرية اللغوية

الخلاصة:

تعتبر نظرية الأفضلية OT من النظريات ذات المنشأ الحديث الذي قدم له برنس و سمولينسكي في ١٩٩٣. تتميز هذه النظرية بكونها نظرية لتفاعل القيود constraints على أساس علاقة الهيمنة بين القيود المتصارعة conflicts ، فلا تتميز كل القيود بالتماسك فيما بينها، لذلك يجب ترتيبها حسب علاقة الهيمنة القائمة بينها ويحتل القيد المنتهك انتهاكا أدنيا (minimal) المكانة الأرقى في سلم ترتيب القيود المتنافسة أو المتصارعة وبناء على الترتيب التفاضلي للقيود تعتبر نظرية الأفضلية أن كل القيود قابلة للانتهاك أو الخرق، لذلك يجب أن تخضع لترتيب متدرج. القيود عالمية واللغات تختلف في ترتيب القيود ranking، وإعطاء أولويات لبعض القيود على الأخرى. وتعتمد هذه التصنيفات على هيمنة صارمة: إذ إن القيد الذي يتفوق على الآخر يعتبر قيماً أعلى مرتبة وله الأولوية.

تحاول هذه الدراسة السعي للحصول على أدلة لإثبات بأن نظرية الأفضلية تحقق أهداف النظرية اللغوية بنجاح.