The optimality of a phonological theory: Review of Bromberger and Halle (1997)

Young-ran An
(Ewha Womans University)

An, Young-ran. 2001. **The Optimality of a Phonological Theory: Review of Bromberger and Halle (1997).** *Studies in Phonetics*, *Phonology and Morphology* 7.1, 85-99. With a bumper crop of researches, OT flourishes not only in phonology but in the other academic areas as well. Against this stream, there are some different observations like Bromberger & Halle (1997; B&H from here on) among others. There will always be pros and cons about a theory; therefore, we need to consider the opposing idea from B&H before we drown in the OT flood. By using the notions of predicates and satisfaction conditions, B&H find OT defective and eventually choose DT as a desirable phonological theory. However, their argument is both too strong and too weak. It is too strong in the sense that it is never suspicious about the existence of derivations. It is too weak in the sense that it vindicates DT via the mechanism of conditionals, which ironically proves that DT cannot give any explanation about failing outputs. **(Ewha Womans University)**

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1. INTRODUCTION

The future phonology may look quite different from what it is today. During the last decade of the twentieth century, phonology turned to a brand new chapter, where Optimality Theory (OT, henceforth) stands out in the limelight. There have also been some observations that OT strikingly resembles Structuralism in that they both pay much attention to allophonic patterns and contrast, surface patterns, functional considerations, and allomorphy. They may all be in the historic circle of phonology, the concept of which is not unfamiliar if we turn our eyes to other social phenomena. Here, however, there are some points that we should be reminded of. That is, OT could be similar to the pre-generative framework in many respects but they are still different from each other. Now that OT emerges on the basis of generative phonology, it places a strong emphasis on formal precision in grammatical analysis and explanatory adequacy.

While OT begins to prosper in phonology and at the interfaces between phonology and other linguistic areas, there remain some proponents of the

previous theory, called rule-based Derivational Theory (DT, henceforth). As OT challenges the extant phonological arguments, it is natural and desirable that OT, in turn, should be counterattacked by other ideas. With Halle and Bromberger in the center, DT still holds its stance, claiming its priority over OT. On the other hand, a spate of recent OT-based papers have alloted some space for showing that OT is preferable to DT theoretically and empirically.

This paper aims to look into one of the papers by Halle and Bromberger and go over some critical points. The next section will present a few questions which are closely related to the agenda of this paper. The overview of Bromberger and Halle (1997; B&H, hereafter) will be given in section 3. In section 4, pros and cons will be provided. The last section will wind up the paper, adding some overall comments.

2. SOME WHY-QUESTIONS

In addition to B&H (1997), the rule-based derivational phonology was already bolstered up in Bromberger and Halle (1989). In pursuit of the question, "Why phonology is different," B&H (1989) argue that the facts pertaining to phonology on the one hand and syntax and semantics on the other are very different in nature and that there is therefore no assumption on their coverage by similar theories. They also observe that the structure of phonology can be best thought of as that of a deductive system.

According to B&H, syntax and semantics are "primarily concerned with the conditions that the deep structure, surface structure, and logical form of a sentence must satisfy. These include conditions peculiar to each level as well as conditions across levels" (1989: 52). However, there is no ordering among principles governing the interconnections among the three representations, nor is there any trace of derivation from any one of the representations to another through a sequential application of rules and intermediate representations. In the meantime, the main concern of phonology is with the links between surface forms which serve as input to the articulatory machinery and the abstract underlying forms stored in memory. Since underlying phonological forms in speakers' memory generate phonetic surface forms in an actual utterance, it makes sense to maintain that surface representations be derived from the underlying representations. As far as the manner of derivation is concerned, phonological rules are applied while subject to the principle as in the following (B&H 1989: 58-59).

(1) Phonological rules are ordered with respect to one another.
A phonological rule R does not apply necessarily to the underlying representation; rather, R applies to the derived representation that results from the application of each applicable rule preceding R in the order of the rules.

In (1) the order of rule application is a language-specific matter. This principle is solidly respected in phonology whereas it is absent from syntax and semantics, the fact of which unfolds one of the answers to why phonology is different.

B&H claim that extrinsically ordered rules obeying the principle (1) play a major role in phonology and they ascribe onus probandi to those linguists who oppose rules and derivations. But there is one point marked here that the absence to the contrary does not mean that a certain existing theory is always right or irresistible.

As is already pointed out, there are at least two kinds of representations in phonology, i.e. phonological and phonetic representations. This fact is well accepted by most linguists and in fact it has led the history of phonological theories. The proponents of DT have tried to offer the account for this by establishing derivations via rules. Meanwhile, the recent OT-theorists attempt to provide a universal explication by virtue of violable constraints and other significant notions. In this way, to the question, "Why phonetic representations are different from phonological ones," DT and OT can furnish a respective answer. Then which answer is right? Can both be true? If we are to choose one over the other, following B&H's observation that overdetermination should be avoided, all we have to do first is to compare DT with OT and weigh the advantages and shortcomings of each theory.[1]

The grammar is an input-output mechanism both in classical generative phonology and in OT. The essential difference between them is due to the fact that the former depends on the "rewrite rules" and the latter on the "output constraints". Rewrite rules are various from language to language while their format is universal. Take a look at the following context-sensitive rewrite rule with A, B, X, and Y denoting natural classes of elements.

[1] By definition of overdetermination, a phenomenon can be explained by two or more processes, which means it can be brought about by one of two or more independent processes, either of which would have been sufficient to bring the phenomenon about. According to B&H (1997), overdetermination is rare and implausible in the absence of strong evidence albeit not impossible.

(2) A → B/X ____ Y

In (2) element A is rewritten as element B in the context of the elements X and Y. The input is to go through exactly one "structural change," if it meets the "structural description" of some rule. Therefore, the application of a rewrite rule shows the process below.

(3) Input: . . .XAY. . .
⇓
Output: . . .XBY. . .

It is noted that the structural description, viz. "trigger" corresponds to a negative constraint, i.e. *XAY in OT and the structural change, a context-free operation by the Generator (Gen) component. In OT, the application of a process relies on Evaluator (Eval), which is instantiated as the language-specific interaction of a markedness constraint and a faithfulness constraint. These facts are summarized as follows (Kager 1999: 54):

(4) a. *XAY 'Avoid the configuration XAY' (markedness)
b. *A → B 'A must not be realized as B' (faithfulness)

(5) a. Ranking for 'application': Markedness ≫ Faithfulness
*XAY ≫ *A → B
b. Ranking for 'non-application': Faithfulness ≫ Markedness
*A → B ≫ *XAY

As is shown above, OT makes use of such theoretically significant concepts as "violable constraints," "constraint ranking," "strict domination" symbolized as ≫, etc.[2] So far, the rule-based theory and OT seem to be fairly similar but they are different in that Gen is free to generate any kind of change, called "candidates" due to Freedom of Analysis.

(6) Freedom of Analysis: Any amount of structure may be posited.

(7) **Gen (input)** ⇒ {$cand_1$, $cand_2$, . . . $cand_n$}
Eval {$cand_1$, $cand_2$, . . . $cand_n$} ⇒ **output**

[2] For more concepts of OT, refer to Prince and Smolensky (1993), Kager (1999), and other OT-based literature.

Two principal differences between the OT and DT arise in due course. One is about the functional unity of processes and the other about intermediate levels. In attaining output goals, "OT predicts that a markedness constraint may trigger various types of structural changes, depending on its interaction with faithfulness constraints" (Kager 1999: 55). DT, by contrast, fails to predict this functional unity of processes since it has no means of expressing the notion of output goals of phonological rules.

One of the important notions for the rule-based theory is "derivation." Application of rules in DT follows the principle of linear, i.e. serial ordering while a parallel mapping in accordance with a hierarchy of constraints is employed in OT.

(8) Lexical representation (Input to Rule 1)
⇓ Rule 1
Intermediate representation (Output of Rule 1, Input to Rule 2)
⇓ Rule 2
Intermediate representation (Output of Rule 2, Input to Rule 3)
:
⇓ Rule *n*
Surface representation (Output of Rule *n*)

As illustrated in (8), each step in the derivation is a miniature input-output mapping. Thus the application of a rule exclusively depends on the structural description of the output from the immediately preceding rule, which means that each rule is blind to the output of the derivation as a whole. Furthermore, the intermediate representations are only present at intermediate stages, which are destined to disappear.

Unless DT and OT are incommensurable in expounding phonological processes, the correctness of either one is to be decided with grounds in empiricism.

3. OVERVIEW

3.1. Basic Ideas

B&H begin their non-empirical considerations by assuming four factors: (i) Phonological symbols stand for predicates; (ii) Within any theoretical approach to phonology, any particular symbol stands for the same predicate

in all contexts; (iii) Phonology is about things in the spatio-temporal world, i.e. about speaker-hearer stages, which is called "this-worldly realism"; (iv) The phonetic characteristics of utterances are not overdetermined, viz. they are not produced by two or more distinct processes, any one of which would have been satisfactory.

According to the first assumption, phonological symbols like phoneme symbols, feature symbols, prosodic segmentation brackets, stress diacritics, etc. can be substituted with "predicates" without any loss of meaning. B&H adopts the term, predicate used in predicate logic, which displays two characteristics. First, it does not denote individual objects or events, but is true of them. The predicate *hot*, for example, does not denote anything but it is true of anything hot. Secondly, it is associated with "satisfaction conditions," which are to define what it is true of. In this sense, predicates are different from "individual constants" which specify their references like *Bill Clinton*, *2*, etc., not providing their own satisfaction conditions. The "lambda notation" is utilized to incorporate familiar terms in more formal symbols as presented below.

(9) a.	λx[hot x](a)	'a is hot'
b.	(∀ y){λx[hot x](y)}	'everything is hot'
c.	λx[+round x](α)	'α is [+round]'
d.	(∃ y){λx[+round x](y)}	'something is [+round]'

The second assumption predicts that phonological symbols are used unambiguously within a single theory. To put it another way, a specific phonological symbol represents the same predicate with the same satisfaction conditions. Hence it is assumed that within DT and within OT, phonological symbols are used unambiguously though not across them. DT respects this semantic unambiguity by nature of rules while OT is committed to semantic unambiguity by way of faithfulness constraints.

In defiance of "instrumentalism" or "Platonism", B&H countenance the argument that a plausible phonological theory should be true and be about things in the actual spatio-temporal worlds. They exclude instrumentalism, pointing out that instrumentalists pay attention only to whether a theory works, ignoring whether it is true, false, probable, or meets other controversial demands. In the meantime, theories like DT or OT seek rules or constraints that have psychological reality. Platonism is attacked in the sense that it allows names of abstract objects as the symbols of phonology, the fact of which is not accepted by an empirical science like phonology.

By the fourth assumption, B&H do not allow any potential possibilities that two separate processes bring about the same correct utterance. Accordingly, DT and OT are expected to entail distinct phonetic predictions. In short, DT and OT cannot be simultaneously right and they count on predicates with different satisfaction conditions. From between these two theories, the theory with more confirming laws and with little disconfirmations will get the better of the other.

As B&H acknowledge, their observation is fundamentally based on theory-internal characteristics of DT and OT, not on specific empirical considerations. They maintain that this kind of argument should be taken into account prior to any empirical evidences in order for the debate between DT and OT to be settled.

3.2. Comparison between DT and OT

In this section, the consequences of the assumptions presented in section 3.1 will be examined, focusing on the semantic content of the phonological symbols in the contexts of DT and OT. After that, there will be comparison between DT and OT under the proviso that they are commensurable.

There is a spatio-temporal utterance given by an actual person at an actual place and actual time. That is, it was produced by SB in Colchester on September 1, 1995 around 3 p.m. local time and in the following it is transcribed in standard English orthography.

(10) Canadians live in houses.

According to DT, the derivation associated with (10) can be furnished as follows.

(11) {[kænæd-i-æn], Noun . . . } + {[z], Pl . . . } + {[liv], Verb . . . } +
{[in], Prep . . . } + {[haʊ:s], Noun . . . } + {[z], Pl . . . }
. . . . . .
. . . . . .
kEnéydiyEnzlIvInháwzEz

The phonological symbol 'k' in the last line can be rendered as a predicate seen in (12b), which assumes that 'A' refers to "SB-at-a-stage-during-the-time-of-the-utterance" ("SB" in short, therefore (12c)) and A, i.e. SB meets the satisfaction conditions of the predicate by SB being in the intentional

mind/brain state that preceded the articulatory gymnastics. Therefore, the predicate (12a) was satisfied because SB had the intention to perform the gymnastic, not because he performed the gymnastic. On the other hand, the phonological symbols in the first line incur a problem since SB did not perform the corresponding gymnastics. This problem, however, is solved through a minor modification of the predicate as in (13).

(12) a. $\lambda x[kx] =_{df} \lambda x[\text{dorsal } x] \ \&\ \lambda x[\text{-continuant } x] \ \&$
$\lambda x[\text{-voiced } x] \ \&\ \lambda x[\text{-nasal } x]$

b. $=_{df} \lambda x[\text{dorsal } x](A) \ \&\ \lambda x[\text{-continuant } x](A) \ \&$
$\lambda x[\text{-voiced } x](A) \ \&\ \lambda x[\text{-nasal } x](A)$

c. $\lambda x[kx](SB)$

d. $\lambda x[Ex] =_{df} \lambda x[\text{-round } x] \ \&\ \lambda x[\text{-high } x] \ \&\ \lambda x[\text{-low } x] \ \&$
$\lambda x[\text{+back } x] \ \&\ \lambda x[\text{-ATR } x]$

(13) a. $\lambda x[\underline{k}x] =_{df} \lambda x[\text{upsr dorsal } x] \ \&\ \lambda x[\text{upsr -continuant } x] \ \&$
$\lambda x[\text{upsr -voiced } x] \ \&\ \lambda x[\text{upsr -nasal } x]$

b. $\lambda x[\underline{æ}x] =_{df} \lambda x[\text{upsr -back } x] \ \&\ \lambda x[\text{upsr -high } x] \ \&$
$\lambda x[\text{upsr +low } x] \ \&\ \lambda x[\text{upsr -round } x]$

(13) defines that at all stages at which SB undertook to produce the utterance in Colchester, he had the intention to perform certain gymnastics "unless precluded by some rule" (abbreviated as "upsr"). According to (13a), SB at an initial stage intended to perform-certain-gymnastics-unless-some-rule-or-rules-preluded-'k' and at a final stage SB had a similar intention. In this case, the "upsr" does not carry any consequences. When (13b) is considered, the analogous explanation can be given but the "upsr" does have consequences because 'æ' is absent from the last line as a result of the rule application.

In the framework of OT, the tableau would have an input identical to the first line of (11) and a winner output identical to the last line of (11). While B&H put aside consideration of non-optimal candidates and constraints, they provide the following predicates similar to those of DT.

(14) a. $\lambda x[\underline{\underline{k}}x] =_{df} \lambda x[\text{uno dorsal } x] \ \&\ \lambda x[\text{uno -continuant } x] \ \&$
$\lambda x[\text{uno -voiced } x] \ \&\ \lambda x[\text{uno -nasal } x]$

b. $\lambda x[\underline{\underline{æ}}x] =_{df} \lambda x[\text{uno -back } x] \ \&\ \lambda x[\text{uno -high } x] \ \&$
$\lambda x[\text{uno +low } x] \ \&\ \lambda x[\text{uno -round } x]$

The "uno" in (14) is short for "unless not optimal according to the UG constraints as ranked for the language of the speaker." The 'k' in the input to GEN records that SB at an initial stage intended to perform-a-certain-gymnastics-unless-this-would-not-be-optimal-etc. and the 'k' in the optimal form says that at a final stage SB had the same intention. The "uno" clause does not take effects in this case but it has influence on the case of 'æ's.

Both DT and OT need to reconcile with three kinds of facts: (i) The fact that each phonemic symbol occurs not in isolation, but ordered with other symbols in whole lines. (ii) Each of these lines in turn occurs not in isolation, but in a derivation or in a tableau. (iii) The derivation or the tableau as a whole pertains not only to the utterance produced by SB in Colchester but to indefinitely many other actual and conceivable utterances. In the following, these three facts are explicated only within the framework of DT since OT can be given an explanation through the same representations except that phonological symbols are double-underlined.

(15) a. $\lambda x[\underline{\underline{\Omega}}x]$

b. $\lambda x[\underline{\underline{\Omega}}x] =_{df} \lambda x[(\exists r)(\exists s)(\exists t) \ldots (\exists u)(\exists v)\{r < s \,\&\, s < t \,\&\, \ldots \,\&\, u < v \,\&\, \lambda y[\underline{k}y](r) \,\&\, \lambda y[\underline{E}y](s) \,\&\, \lambda y[\underline{n}y](t) \,\&\, \ldots \,\&\, \lambda y[\underline{E}y](u) \,\&\, \lambda y[\underline{z}y](v) \,\&\, \Sigma\{r,s,t, \ldots u,v\} = x\}]$

c. $\lambda x[\underline{\underline{\Omega}}x](SB)$

. .

. .

(16) a. $\lambda x[\underline{\Gamma}x]$

b. $\lambda x[\underline{\Gamma}x] =_{df} \lambda x[(\exists l)(\exists m) \ldots (\exists n)(\exists o)\{l < m \ldots \,\&\, \ldots \,\&\, n < o \,\&\, \lambda y[\{[\underline{k}\text{ænæ}\underline{d}\text{-}\underline{i}\text{-}\underline{æ}[sic]], Noun \ldots\} y](l) \,\&\, \lambda y[\underline{z}, Pl \ldots]y](m) \,\&\, \ldots \,\&\, \lambda y[\{[\underline{h}\text{ɬ}\underline{s}], Noun\}y](n) \,\&\, \lambda y[\underline{z}, Pl \ldots \}y](o) \,\&\, \Sigma\{l,m, \ldots n,o\} = x\}]$

c. $\lambda x[\underline{\Gamma}x](SB)$

With the first fact DT reconciles by explaining that the phonological symbols in the line signify that their stand-ins, i.e. the predicates are part of the expansion of the more complex predicate. (15a) and (16a) are the abbreviated predicates in the last and first lines respectively. (15b) and (16b) are definitions of the a-counterparts while (15c) and (16c) are their respective rough paraphrases. (15c) asserts of a stage of SB (i) that it was made up of subsidiary stages (r,s,t, . . . u,v); (ii) that these subsidiary stages occurred chronologically so that r came before s, s before t, . . . u before v; and (iii) that the first of these stages, r, was a $\underline{k}$, in other words, met the

satisfaction conditions of "λy[ky]", that the second of the stages met the satisfaction conditions of "λy[ey]", . . . and that the last stage met the satisfaction conditions of "λy[zy]". (16c) gives an assertion about a stage of SB (i) that it was made up of a number of subsidiary stages (l,m, . . . n,o); (ii) that these subsidiary stages were ordered so that l was prior to m, . . . n prior to o; (iii) that the first of these stages was a stage of the predicate "being the intention of uttering the noun pronounced [kænædiæn] unless some rule or rules require modification" . . . that the last stage is of the predicate "being the intention of uttering the plural morpheme pronounced z unless some rule or rules require modification."

(17) a. $\lambda x[\underline{\Gamma} x](SB_1)$ & $\lambda X[\underline{\Delta} x](SB_2)$ & $\lambda xy[\underline{\text{motivate}}\ xy](SB_1\ SB_2)$ & . . . . $\lambda x[\underline{\Lambda} x](SB_m)$ & $\lambda x[\underline{\Omega} x](SB_n)$ & $\lambda xy[\underline{\text{motivate}}\ xy](SB_m\ SB_n)$ & $\neg\ (\exists t)\{\lambda xy[\underline{\text{motivate}}\ xy](SB_n t)\}$

b. $\lambda xy[\underline{\Gamma} x](SB_1)$ & $\lambda x[\underline{\Omega} x](SB_m[\text{sic}])$ & $\lambda xy[\underline{\text{motivate}}\ xy](SB_1\ SB_n)$

The derivation as a whole can be rendered as (17a), which means two things. One is that SB went through a series of stages in Colchester, i.e. through the first and intermediate stages all the way to the last one. The dyadic predicate, "λxy[motivate xy]" meets its satisfaction conditions through a causal process modulated by internalized phonological rules, the fact of which implies the transitivity of predicates as in (17b). By virtue of (17), DT reconciles with the second fact presented above.

(18) a. $\Delta(\forall z)\{\lambda x[\underline{\Gamma} x](z) \rightarrow (\exists u)\{\lambda x[\underline{\Delta} x](u)$ & $\lambda xy[\underline{\text{motivate}}\ xy](zu)\}$ & . . . . $(\exists v)\{\lambda x[\underline{\Lambda} x](v)$ & $(\exists w)\lambda x[\underline{\Omega} x](w)$ & $\lambda xy[\underline{\text{motivate}}\ xy](vw)$ & $\neg\ (\exists t)\{\lambda xy[\underline{\text{motivate}}\ xy](wt)\}\}\}$

b. $\Delta(\forall z)\{\lambda x[\underline{\Gamma} x](z) \rightarrow (\exists w)\{\lambda x[\underline{\Omega} x](w)$ & $\lambda xy[\underline{\text{motivate}}\ xy](zw)$ & $\neg\ (\exists t)\{\lambda xy[\underline{\text{motivate}}\ xy](wt)\}\}\}$

To accommodate the third fact, B&H offer a law, viz. a nomological generalization that happens to have been instantiated by SB in Colchester, need not have been instantiated to be true. By hiring the modality symbol, "Δ," the law (18a) entails counterfactual conditionals, not giving an ordinary accidental generalization. (18a) states that to any stage satisfying the predicate of the first line, there must be a stage satisfying the predicate

of the second line motivated by the former, . . . and a stage satisfying the predicate of the last line motivated by a stage satisfying the predicate of the penultimate line, but motivates no further stage. The transitivity again plays a role in entailment from (18a) to (18b). Therefore, this law has a domain of spatio-temporal entities, i.e. speaker-stages but it can be true even if no entity in that domain ever meets its antecedent conditions.

As was pointed out, the three considerations above can be dealt with within OT in an analogous way. However, there is no transitivity role since OT dispenses with derivations or rules. Moreover, one of the fundamental differences between DT and OT comes from an infinitude of candidates existing in OT. Hence the nomological generalizations of winner outputs along with loser ones are presented as follows.

(19) a. $\Delta(\forall z)\{\lambda x[\underline{\underline{\Gamma}}x](z) \rightarrow (\exists w)\{\lambda x[\underline{\underline{\Omega}}x](w)$ &
$\lambda xy[\underline{\text{motivate}}\ xy](zw)\}\}$

b. $\Delta(\forall z)\{\lambda x[\underline{\underline{\Gamma}}x](z) \rightarrow \neg (\exists w)\{\lambda x[\underline{\underline{\Delta}}x](w)$ &
$\lambda xy[\underline{\text{motivate}}\ xy](zw)\}\}$

Under the assumptions that the two theories DT and OT are not incommensurable and there is apparently no overdetermination in accounting for any one process, B&H argue that the theory with the largest number of confirmed laws and explanations should be preferred. They also note that the phonetic predicates in the laws would play a crucial role in choosing a best theory. Finally they decide that DT be chosen over OT owing to the answers to some questions they place.

(20) Why do English speakers say 'kEnéydiyEnzlIvInháwzEz,' that is, get to a stage satisfying '$\lambda x[\Omega x]$' and not 'kænæydiænzlivinh~~I~~:sEz,' a stage satisfying some other predicate?

(21) What is the sequence of the stages traversed (the set of predicates satisfied) by a speaker in the course of producing utterances satisfying e.g. '$\lambda x[\Omega x]$' from mnemonic elements merged and structured by the syntax of that speaker?

(22) In what respect is an utterance satisfying '$\lambda x[\Omega x]$' optimal?

To (20), DT and OT can come up with answers albeit different. With respect to (21), only DT can give an answer since OT basically makes no

allowance for intervening stages. (22) is designed for only OT to give an answer but B&H suspect the notion of optimality, claiming that (21) is a legitimate question accepted by all phonologists. Consequently, even if a computational algorithm in the brain of speakers is assumed, DT is construed as more plausible and simpler in that it provides more psychological accounts through derivations with smaller number of intermediate stages.

4. DISCUSSION

In this section, several doubts will be brought up and given some thought. In the first place, it is admitted that in a sense, any theory primarily must be evaluated on the basis of non-empirical but fundamental considerations. However, it is also true that no efficiency will possibly be begotten without examining any specific empirical evidence. As most scientists may agree, any nice-looking argument void of real data will be invalid.

Secondly, if the two theories DT and OT are to be practically commensurable, OT should not have been considered without its core concepts such as "violable constraints" and "candidates." Due to this mistake, there has been a fallacy in B&H's giving satisfaction conditions to the predicates in OT. That is, they should have furnished a condition like "unless precluded by some constraint," rather than "unless not optimal according to . . . (i.e. uno)." In addition, it is worth noting that by removing rules and derivations, OT has been able to get rid of the vexing problem, "abstractness." In a sense, loser candidates in OT can correspond to the intermediate representations in DT. The psychological reality about these abstract representations mentioned by B&H comes in doubt.

Thirdly, the Tesar-like algorithms do not exhaust the computational processes that can be thought of as the real one occurring in the speakers' brain. Since the working of OT in many areas is under way, the Tesar-like algorithm should be considered as the only one example. And here, one very important point has to be made about the algorithms. The algorithms are different in nature from derivations. The algorithms in OT are applied in a parallel and one-fell-swoop way, whereas the derivations via rules are provided in a (temporally) serial order. Furthermore, the attack by B&H would be backfired if it is seen from a different angle. That is, even to the field of the computer science, OT can be applied and this gives it a wide generalization.

Fourth, the concept "optimality" suspected by B&H is, in fact, plausible

and viable. To put it another way, this relative notion is more compatible with our linguistic life than the absolute notion, "one output from one derivation." The definition of "optimality" and a related idea are given below (Kager 1999: 13, 16).

(23) Optimality: an output is "optimal" when it incurs the least serious violations of a set of constraints, taking into account their hierarchical ranking.

(24) Fallacy of perfection: no output form is possible that satisfies at all constraints.

Last but not least, let us consider the truth values of conditionals. Since B&H introduce conditionals in presenting appropriate interpretations for DT and OT, the truth table of conditionals need to be furnished as in (25). Along with it, the generalizing laws in the previous section are repeated here as (26) and (27) for convenience' sake.

(25)

p	q	p → q
T	T	T
T	F	F
F	T	T
F	F	T

(26) a. $\Delta\ (\forall z)\{\lambda x[\underline{\Gamma} x](z) \rightarrow (\exists u)\{\lambda x[\underline{\Delta} x](u)\ \&$
$\lambda xy[\underline{\text{motivate}}\ xy](zu)\}\ \&\ \ldots .\ (\exists v)\{\lambda x[\underline{\Lambda} x](v)\ \&$
$(\exists w)\lambda x[\underline{\Omega} x](w)\ \&\ \lambda xy[\underline{\text{motivate}}\ xy](vw)\ \&$
$\neg\ (\exists t)\{\lambda xy[\underline{\text{motivate}}\ xy](wt)\}\}\}$

b. $\Delta(\forall z)\{\lambda x[\underline{\Gamma} x](z) \rightarrow (\exists w)\{\lambda x[\underline{\Omega} x](w)\ \&$
$\lambda xy[\underline{\text{motivate}}\ xy](zw)\ \&\ \neg\ (\exists t)\{\lambda xy[\underline{\text{motivate}}\ xy](wt)\}\}\}$

(27) a. $\Delta(\forall z)\{\lambda x[\underline{\Gamma} x](z) \rightarrow (\exists w)\{\lambda x[\underline{\underline{\Omega}} x](w)\ \&$
$\lambda xy[\underline{\text{motivate}}\ xy](zw)\}\}$

b. $\Delta(\forall z)\{\lambda x[\underline{\Gamma} x](z) \rightarrow \neg\ (\exists w)\{\lambda x[\underline{\Delta} x](w)\ \&$
$\lambda xy[\underline{\text{motivate}}\ xy](zw)\}\}$

As B&H explain, the proposition like (26b) can, without harm, be

paraphrased as describing a relationship between an underlying representation and a surface representation, i.e. between p and q in (25). The third case in (25) can be given an explanation that even if there is no entity which meets the antecedent conditions, the proposition can be true. However, what about the second case in (25)? This one means that a true input produces a false output, which cannot be accounted for within the mechanism of DT. In the meantime, OT can do away with this stumbling block by way of the proposition like (27b). In (27b) losing output forms are expressed.

Even with some detailed doubts aside, the issues set forth above suffice to bring B&H's argument into question.

5. CONCLUDING REMARKS

To recapitulate what has been discussed in the previous sections, an interesting intuitive analogy from Tesar (1995: 3) can be introduced.

> . . . Suppose that there are two towns, X and Y. In between these towns is a river, which must be crossed in order to travel from X to Y. There are three bridges across the river: A, B, and C. Suppose that we wish to find the shortest — the optimal — route from X to Y.
>
> We know that any path between X and Y must cross one of the three bridges. There are many different ways to get from Town X to each of the three bridges, and many different ways to get from each of the bridges to Town Y. However, we can simplify our problem by first only considering the best way to get from X to A, the best way from X to B, and the best way from X to C. Having found each of these "sub-routes," we could make a small table for future reference: it would have three entries, each giving the route and the distance of the route to one of the bridges. . . .

In this context, OT is one of the theories supported by our intuition. Although it still has not a few problems, it cannot be denied that OT has predictive power in many linguistic phenomena and has conceptual and computational grounds.

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Dept of English Lang & Lit
Ewha Womans University
#11-1 Daehyun-dong, Seodaemoon-ku
Seoul, 120-750, Korea
Email: yran@ewha.ac.kr