Rethinking Transfer:
Perception and Production of Nonnative Contrasts

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Abstract

In this paper, we explore the perception and production of non-native phonological units and the types of errors made by speakers when they are confronted with unfamiliar input, notably those traditionally ascribed to transfer. Our discussion combines experimental evidence for the distinction between perception and production grammars, as well as the role of L1 interference upon each of these, with proposed Optimality Theoretic (OT, Prince & Smolensky 1993) formalizations of complementary grammatical modules. The paper proceeds in two sections, focusing on experimental evidence and on formal account of results, respectively.

We first review an experiment mimicking naturalistic language contact. Subjects (monolingual English and bilingual French-English) were confronted with vowel stimuli, including novel tokens (e.g. [y] for monolinguals and [ʉ] for bilinguals). Subjects heard carrier phrases containing target nonce words and were asked to identify these using a forced response matrix. Speakers were then presented the words in isolation and asked to reproduce them orally. Task output was analyzed, noting error rates and productive adaptations for each group. Results support a distinction between perceptual and productive knowledge and the effect of these on putative errors. Monolingual speakers failed to accurately perceive novel contrasts, but were relatively successful at reproducing target vowels, whereas bilingual speakers typically perceived contrasts present in either French or English (e.g. /y/ *vs.* /u/), but sometimes failed to produce these.

We next formalize the results of our experiment in complementary perception and production grammars. The former comprises constraints referring to the parsing of experiential (auditory) input and the categorization of contrast; interference concerns the transfer of L1 constraint rankings, reflecting speaker attenuation to L1 contrasts. The latter is formalized around phonetically-based constraints referring to phonetic patterns, the preservation of underlying (L1) featural information and effort minimization (Kirchner 1998, Steriade 2001, Hayes 2004); here, learned patterns of L1 production, expressed as constraint rankings, are shown to predict surface forms.

Finally, we address the disciplinary advances stemming from the present line of experimental and theoretical work, focusing on two language contact profiles: second language learning and creole formation. In the former, greater understanding of perception and production grammars affords more insight into the interlanguage dynamic; in the latter, formalization of distinct strata addresses the adequacy of explanatory models accounting for grammatical restructuring.

I. Background

A. Basic issues and underlying questions

☞ The role of **transfer** in the emergence and evolution of L2 phonology
- To what extent can surface errors be attributed to the transfer of L1 grammatical structure onto incipient L2?
  - What might be other sources of L2 grammatical deviations?
- Accepting transfer, is this due to the calquing of L1 productive or perceptual grammatical structure (or both)?

☞ **Formalizing** productive and perceptual interference in Optimality Theory (OT, Prince & Smolensky 1993)
- How can the architecture of OT be modified to facilitate the distinction between production and perception?
- How can such a grammar account for both the synchronic state of an L2 grammar and the diachronic evolution of this grammar?

B. Goals of Our Research

- To provide **experimental evidence** for transfer as a causal factor in the emergence of L2 grammatical structure and diachronically divergent L2 surface forms;
  - Distinguishing between productive and perceptual transfer

- To articulate **formal models** of L2 grammars which are both descriptively and explanatorily adequate;
  - Within an OT framework

C. Literature Review

- Three areas of L2 'speech' research (Leather & James 1991, 1996)
  1. *linguistic constraints* (perception, production, their interrelation, and the potential role of transfer)
  2. *maturational constraints* (critical period or (de)cline in ability to approximate)
  3. *individual/social constraints* (motivation, social acceptance and distance, personality variables, gender and sociosexual disposition, oral and auditory capacities)

- 'Success' (or lack thereof) in the production of L2 sounds attributable to accuracy of perceptual targets, knowledge of production rules (articulatory routines), or likely both.
  - Perception and production are also likely influenced by the primary language in some way(s)

- **Perception**:
  - "Abundant evidence that the beginning learner seeking to impose phonetic structure on the L2 speech to which he is exposed makes perceptual reference to the categories of his L1" (Leather & James 1996:273-274)
    - most research centered on VOT.
  - Most likely scenario involves a process of 'equivalence classification' (Flege 1987)

    - L1 phonetic categories are projected onto the sounds of the L2 where possible, even if there are detectable acoustic differences between the two;
    - L2 sounds resisting such classification will be the subject of new phonetic category construction.

  ☞ The learning task may be more difficult in the former because the L1 category may cause learners to develop inaccurate perceptual targets.

- **Production**: L1 articulatory routines may play a part in L2 production
  - Early research couched in structuralist terms; classic constrastive analysis and the substitution of L1 segmental phonemes for ones in the L2
  - More recent research finds this to be an oversimplification; the 'strong' version of CA makes inaccurate predictions and full analysis at the phonetic level is needed.

- **Interrelation of perception and production**:
  - Positive correlation between perception and production abilities…
  - …but such a correlation is not *highly* positive, nor has its directionality been successfully demonstrated
  - "[Extant research studies] do not constitute clear evidence of any constant and simple correspondence between perception and production – which should therefore not be viewed as two sides of the same coin" (Leather & James 1996:284).

- **L1 influence ('transfer')**:
  - Is transfer to be construed as a projection from the L1 onto the L2 as an initial state, after which more general developmental processes occur?
    - i.e., transfer as found in the *product* of language ontogeny
  - Or should transfer be construed as one of several strategies utilized or influencing acting upon processing by the learner in development (e.g., typological markedness, contextual effects [immediate phonetic environment])?
    - i.e., transfer found in the *process* of language ontogeny

- A dearth of studies on the L2 acquisition of French phonology (viz. Hannahs 2007) and few extant studies on the perception and production of front rounded vowels in particular
  - L1 English learners of L2 French were better at producing French /y/ (with no counterpart in English) than French /u/ (which differs acoustically and in its articulation from English /u/); with an increase in exposure to L2 input, greater accuracy is achieved (Flege 1987; Flege & Hillenbrandt 1987)

  - An overwhelming perceptual assimilation of French front rounded vowels /y/ and /œ/ to back American English vowels (Levy, 2004), though extensive immersion experience did yield somewhat better perception (= discrimination)
  - Questionable influence of orthography (viz. Vendelin & Peperkamp 2006)
    - e.g. /y/ (= <*ou*>) ≅ <*u*> → /u/

D. *Research Questions*

☞ How do monolingual English speakers – absent explicit pedagogical intervention – perceive and produce nonnative vowels (e.g., front, rounded [y] and [ø] and back, unrounded [ɯ] and [ʏ])?

☞ How do bilingual English-French speakers perceive vowels present in the inventory of at least one of the languages (e.g., [y] and [ø]) versus those present in neither language (e.g., [ɯ] and [ʏ])?

☞ Does frequency of input featuring nonnative values lead to greater accuracy?

II. Experiment

A. *Pilot Study*

Participants

- 20 participants (ages 29-52, approx. equal M/F), screened for normal hearing and language background using a self-report.
  - monolingual English speakers (*n = 10*): native speakers of American English; lacking competence in another language beyond novice proficiency; have never studied an L2 having front rounded or back unrounded vowels (e.g. French, German, Japanese, Korean)
  - bilingual English-French group (*n=10*): advanced, near-native or native in both languages

Task Design

<u>Part 1</u>: forced choice

- Participants listen to carrier phrases containing target words, some of which contain vowels that are not familiar to them (e.g. [y])
- Subjects are asked to select, from multiple choice, forced-response matrices, the orthographic form which they feel best represents target aural stimuli.

Table 1. *Target words in auditory stimuli, transcribed using IPA.*

vowel target→ consonant environment↓	**[i]**	**[y]**	**[e]**	**[ø]**	**[u]**	**[o]**
[b]	bib	byb	beb	bøb	bub	bob
[d]	did	dyd	ded	død	dud	dod
[g]	gig	gyg	geg	gøg	gug	gog
[f]	fif	fyf	fef	føf	fuf	fof
[s]	sis	sys	ses	søs	sus	sos
[h]	hi	hy	he	hø	hu	ho

Table 2. *Examples of target words with [f] as consonant environment and response choices, as they appear in conventional spelling*

Target	**monolingual choices**	**bilingual choices**
[fif]	*feef fayf foof*	*fife féfe fufe*
[fyf]	*feef foof fayf*	*fufe fife fouf*
[fef]	*fayf feef fowf*	*féfe fife feuf*
[føf]	*fayf fowf feef*	*feuf féfe fauf*
[fuf]	*foof fowf feef*	*fouf fufe fauf*
[fof]	*fowf foof fayf*	*fauf feuf fouf*

Part 2: stimulus-feedback response

- Participants reproduce stimulus tokens (same sentences from Part 1)
- Subject production of the target word is recorded and measured (impressionistically and instrumentally)

B. Results

Table 3. Monolingual perception task (expressed as %)

response→ input↓	|u|	|o|	'schwa'	|ju|	|i|	|e|
[y]	61	0	8	28	3	0
[ø]	8	0	89	0	3	0

- Majority of monolinguals perceived stimulus words containing [y] as being variants of |u| or of the sequence |ju|, such that the perception of surface features corresponding to [+round] outweigh those corresponding to place (i.e. [±front])
- Distinct results were obtained in the case of [ø] stimuli, which were perceived by the majority as being variants of schwa; we hypothesize this involves speaker knowledge of possible vowel reduction in English

Table 4. Monolingual production task (expressed as %)

response→ input↓	[y]	[ø]	[u]	[o]	'schwa'	[ju]	[i]	[e]
|y|	33	0	56	0	3,3	0	3,3	3,3
|ø|	0	30,5	5,5	0	64	0	0	0

- Speakers were relatively more successful at preserving the featural contrasts of stimuli, producing [y] and [ø] in approximately one third of all cases
  - [u] most frequent production variant of |y|
  - schwa-like produced by the majority of subjects for input |ø|
- Results support the hypothesis that perception and production are governed by distinct phonological knowledge modules.

D. Ongoing (Large Corpus) Study

- Larger sub-groups (monolingual = 50, bilingual = 50)
- Testing for effect (1 vs. 3 repetitions of stimuli)
- Richer input (including [ʏ], [ɯ] tokens)
- Computer generated testing platform

III. Phonological Grammar

A. Implications of experiment for phonological grammar

Optimality Theory (see e.g. Kager 1999 for general orientation)

- combines universal, violable constraints in a hierarchy
- distinguishes between faithfulness (input-output fidelity) and markedness (output structural well formedness)
- **Our proposal**: human grammars are stratified to (at least) two input-output processes (Boersma 1998 et seq., Bradley & Russell Webb 2007 & MS, Russell Webb *in press* b, c and MS; see also e.g. Kenstowicz 2003, Rubach 1997 et seq., Kiparsky 2000 et seq.)

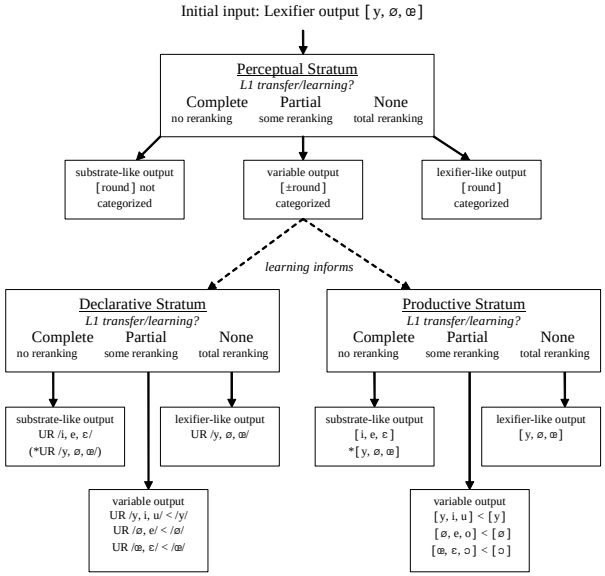
Transfer in OT:

- transfer describes the 'calquing' of L1 grammatical properties onto the incipient L2
- in OT, grammatical properties are constraint rankings
  - transfer = the innovative ranking of constraints
  - output/surface 'errors' or 'divergences' are the product of constraint ranking and constraint interaction and not a result of input divergence (Smolensky 1996; but cf. Hale & Reiss 1998, Reiss 2000, Russell Webb *in press* b & MS)

B. Distinction between perception and production

- perception: input = experiential signal; output = posited abstract representations; constraints refer to the parsing and categorization of information in the experiential signal
- production: input = abstract representations (posited featural information in a particular architecture); output = surface structural descriptions; constraints refer to structural well formedness and input-output correspondence between underlying and instantiated/surface form

Figure 1. The interaction of perceptual, declarative and productive strata in creolizing language contact (from Russell Webb *in press* c)



C. Modeling competences

i. Input processing and the perceptual stratum

- Input = experiential auditory signal (i.e. output of another speaker; see Boersma 2004)
- Constraints refer to the parsing of surface features (faithfulness) and to the categorization of underlying features corresponding to these (markedness)
- Output = abstracted/filtered auditory structural description (viz. the Phonetic Decoding Module of Best 1994 et seq.; Peperkamp 2003 & Dupoux 2003, MS.)

☞ Perceptual Faithfulness (Boersma 1998: 189, 164)

- PARSE(F2): surface features corresponding to F2 should appear in the underlying form ('output should be faithful to input [± front]')
- PARSE(lowFF): surface features corresponding to the relative distribution of formant frequencies and their lowering should appear in the underlying form ('output should be faithful to input [± round]')

☞ Perceptual Markedness (Kager 1999:100)

- *CATEG(lowFF, round): the surface feature [lowFF] should not be categorized as the value [round] ('do not categorize [±round]')
- *CATEG(highF2, front): the surface feature [highF2] should not be categorized as the value [front] ('do not categorize [±front]')

Table 5. Example of Perceptual Evaluation, monolingual: experiential input [y]

[y]	PARSE(F2)	*CATEG (lowFF, round)	PARSE(lowFF)	*CATEG (highF2, front)
☞ |i|			*	*
|u|	*!	*		*
|y|		*!		*
|ɯ|	*!		*	*

☞☞ Grammar models the monolingual's reception and processing of a nonnative experiential stimuli: output = "what the subject has 'heard'"

ii. Output processing and the Productive Stratum

- Input = abstract structural description
  - Particularity of the stimuli used for this study: immediate feedback and short timeframe may not allow for the position of fixed UR
- Constraints refer to the physical actuation of abstract structure, involving cue preservation (faithfulness) and effort reduction/minimization (markedness)
- Output = surface structural description

☞ Productive Markedness (Kirchner 1998; Russell Webb *in press* a, b)

- -EFFORT(lab): do not contract the lips (abbreviated *Lab)
- -EFFORT(tongue): do not contract tongue muscles
  *HighT: no high tongue gesture

☞ Productive Faithfulness (Steriade 2001; Wright 2004, 2006)

- PRES(F1): Preserve cues pertinent to F1
- PRES(F2): Preserve cues pertinent to F2
- PRES(F1F2): Preserve cues pertinent to F1 – F2

Table 6. Example of Productive Evaluation, monolingual: input /y/

/y/	[*HighT, *Lab]	PRES (F2)	PRES(F1F2)	*HighT	*Lab
[y]	*!	*		*	*
☞ [u]				*	*
[i]		*!		*	
[ɯ]			*!	*	

☞☞ Grammar models the monolingual's production of nonnative stimuli: output = "subject articulation of putative underlying structure"

IV. Implications for future work

L2 Phonological Acquisition

- Additional evidence for L1 influence in perception and production
  - favoring a *product* view but not discounting a *process* view
- A clearer understanding of what's involved in interlingual comparison
- Lack of clear evidence of any constant and simple correspondence between perception and production explained by bifurcation of competence
- By concentrating solely on linguistics constraints, we cannot offer (yet) a global model of second language 'speech'

Contact language study

- conflation of L2A as a type of contact linguistics
  - naturalistic and controlled L2A
  - creolization and pidginization
  - other cases of "untutored L2A/L"

Grammar theory

- bifurcation of linguistic competence
  - greater explanatory power of grammatical models
  - grammar makes direct reference to extra-grammatical forces acting upon it (cognition, biomechanics, etc.)
- stratification of serial grammar
  - more "mentalist" and "physiological" views of the grammar (viz. Hale & Reiss 1998, Reiss 2000, McMahon 2000)

References

Best, C.T. 1994. The Emergence of Native-Language Phonological Influences in Infants: A Perceptual Assimilation Model. *The Development of Speech Perception*, J.C. Goodman & H.C. Nusbaum (eds), 167-224. Cambridge: MIT Press.

Boersma, P. 1998. *Functional Phonology: Formalizing the interactions between articulatory and perceptual drives*. Leiden: Holland Academic.

Boersma, P. 2004. The Richness of the Base is in Comprehension. Presentation, Johns Hopkins University, 22 September 2004.

Bradely, T. & E. Russell Webb. MS. Rhotic Metathesis Asymmetries in Romance: Formalizing the effects of articulation and perception on sound change. University of California, Davis.

Bradely, T. & E. Russell Webb. 2007. Accounting for Rhotic Metathesis: The interplay of articulation and perception. Presentation to the Linguistics Society of America.

Flege, J. E. 1987. Effects of equivalence classification on the production of foreign language speech sounds. *Sound patterns in second language acquisition*, A. James & J. Leather (eds.), 9-39. Dordrecht: Foris.

Flege, J. E., & Hillenbrandt, J. 1987. Limits on phonetic accuracy in foreign language speech production. *Interlanguage phonology*, G. Ioup & S. H. Weinberger (eds.), 176-203. Cambridge, MA: Newbury House.

Hale, M. & C. Reiss. 1998. Formal and Empirical Arguments concerning Phonological Acquisition. *Linguistic Inquiry* 29.4: 656-683.

Hannahs, S. J. 2007. French phonology and L2 acquisition. *French Applied Linguistics*, D. Ayoun (ed.), 50-74. Amsterdam: Benjamins.

Hayes, B.. 2004. Phonetically Driven Phonology: The Role of Optimality Theory and Inductive Grounding. *Optimality Theory in Phonology*, J.J. McCarthy (ed.), 343-364. London: Blackwell.

Kenstowicz, M. 2003. The role of perception in loanword phonology. *Studies in African Linguistics* 32:95-112.

Kiparsky, P 2000. Opacity and cyclicity. *Linguistic Review* 17.2-4:351-365.

Kirchner, R. 1998. *An Effort Based Approach to Consonant Lenition*. Doctoral Thesis, University of California, Los Angeles.

Leather, J.,& James, A. 1991. The acquisition of second-language speech. *Studies in Second Language Acquisition*, 13:305-341.

Leather, J., & James, A. (1996). Second language speech. *Handbook of second language acquisition*, W. C. Ritchie & T. K. Bhatia (eds.), 269-316. San Diego: Academic Press.

Levy, E. S. 2004. Effects of language experience and consonantal context on perception of French front rounded vowels by adult American English learners of French. PhD dissertation, The City University of New York.

McMahon, A. 2000. *Change, Chance, and Optimality*. Oxford: Oxford UP.

Peperkamp, S. & E. Dupoux. 2003. Reinterpreting loanword adaptations: the role of perception. *Proceedings of the 15th International Conference of Phonetic Sciences*, 367-370.
Peperkamp, S. & E. Dupoux. MS. Learning the mapping from surface to underlying representations in artificial language. To appear in *Laboratory Phonology 9*, J. Cole & J. Hualde (eds.).
Prince, A. & P. Smolensky. 1993. Optimality Theory: constraint interaction in generative grammar. *Technical Report 2 of the Rutgers Center for Cognitive Sciences*. Cambridge: MIT Press.
Reiss, C. 2000. Optimality Theory from a Cognitive Science Perspective. *The Linguistic Review* 17:191-201.
Rubach, J. 1997. Extrasyllabic Consonants in Polish: Derivational Optimality Theory. *Derivations and Constraints in Phonology*, Iggy Roca (ed.), 551-581. Oxford: Clarendon.
Russell Webb, E. *In press* a. Effort Reduction and Effort Avoidance: Liquids in Haitian and St. Lucian. *Creole Language Library*, M. Hübner (ed.). Amsterdam: Benjamins.
Russell Webb, E. *In press* b. Explanatory Adequacy in Phonology: a deductive approach to /R/. *Linguistica Atlantica*.
Russell Webb, E. *In press* c. Formalizing Creole Sound Change: An Optimality Theoretic Account. *Journal of Pidgin and Creole Linguistics*.
Russell Webb, E. MS. Representations matter: Emergent Features, Modular Competence and French /R/. University of California, Davis (Rutgers Optimality Archives).
Smolensky, P. 1996. The Initial State and 'Richness of the Base' in Optimality Theory. Johns Hopkins University, Technical Report JHU-CogSci-96-4.
Steriade, D. 2001. The Phonology of Perceptibility Effects: the P-map and its consequences for constraint organization. MS, UCLA.
Vendelin, I. & S. Peperkamp. 2006. The influence of orthography on loanword adaptations. *Lingua* 116:996-1007
Wright, R. 2001. Perceptual cues in contrast maintenance. *The role of speech perception phenomena in phonology*, E. Hume & K. Johnson (eds.), 251-277. San Diego: Academic Press.
Wright, R. 2004. A review of perceptual cues and cue robustness. *Phonetically Based Phonology*, B. Hayes, R. Kirchner & D. Steriade (eds.), 34-57. Cambridge: Cambridge UP.

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