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# Speakers' Sensitivity to Rules of Frozen Word Order

STEVEN PINKER AND DAVID BIRDSONG

*Harvard University*

Certain idioms called "freezes," e.g., *first and foremost, mish-mash,* display a characteristic fixed word order determined by phonological and semantic rules. Native speakers of English and learners of English were asked to indicate their preferences for one of two possible orderings of minimally contrasting nonsense pairs, e.g., FIM–FUM versus FUM–FIM. Both native and beginning speakers' judgments respected rules claimed to be universal; only native speakers' judgments respected those rules for which evidence for universality is lacking. In a second study, French native speakers and English native speakers learning French judged French-sounding pairs. Once again, overall judgments respected the putatively universal rules; but only the English speakers' judgments respected the putatively English-specific rules. It is concluded that rules of frozen word order are psychologically real, with the possible function of aiding speech perception.

The class of idiom-like expressions known as "freezes" constitutes one of those linguistic domains in which an apparently superficial phenomenon is found to be governed by surprisingly orderly and deeply rooted principles. Referred to by many names and prevalent in most languages, freezes include irreversible conjoined phrases such as *wear and tear, hook, line, and sinker, first and foremost;* and fixed reduplicatives, which subdivide into vowel alternations, e.g., *pitter-patter, ping-pong;* and into rhyming terms such as *super-duper, razzle-dazzle,* and *hocus-pocus.* In all of these expressions, the salient and defining characteristic—and the focus of our investigation—is the fixed or "frozen" linear order of their constituent terms.

Literally dozens of principles purporting to account for this invariability have been proposed. The principles range from ad hoc, language-specific rules (e.g., Abraham, 1950; Scott, 1913; Morawski, 1927) to powerful, universal, or quasi-universal principles (e.g., Jespersen, 1942; Marchand, 1969; Malkiel, 1968). The consensus among modern linguists is that both phonological and semantic factors are responsible for word ordering in freezes.

Purely semantic factors seem to be preeminent in determining word order in irreversible conjoined phrases. Cooper and Ross (1975) suggest a broad principle which rules that first members of conjoined expressions refer to those features which describe or

The order of authors was determined by the Vowel Quality Principle. Portions of this paper were presented at the Third Annual Boston University Conference on Language Development, September 1978. The research reported here comprises part of the second author's doctoral dissertation submitted to the Department of Romance Languages, Harvard University. We are grateful to Lloyd Anderson, Roger Brown, William Cooper, Wilga Rivers, Jean-Pierre Montreuil, Dan Slobin, and especially to John R. Ross for helpful discussions and advice; to J.-P. Montreuil and Faith Steinberg for assistance in preparing the stimulus materials; and to Nancy Etcoff and Roger Tobin for assistance in data analysis. Of course, none is to be blamed for the paper's faults. The staff and students in Romance Languages at Harvard, and in the English as a Second Language programs at Boston University, Harvard, and the International Institute, also deserve sincere thanks. This research was supported by Graduate Student Research Funds from the Department of Psychology and Social Relations, Harvard University, to the first author, who was supported by a NRC Canada Postgraduate Scholarship. Address reprint requests to either the second author, now at the Department of French and Italian, University of Texas, Austin, Texas 78712, or the first author, now at the Center for Cognitive Science, 20D-105, M.I.T., Cambridge, Massachusetts 02139.



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pertain to the prototypical speaker (hence, the "Me First" principle). The first elements tend to be, e.g.:

| | |
|---|---|
| Living | *the quick and the dead; life or death* |
| Adult | *parent and child; men, women, and children* |
| Male | *man and woman; brother and sister* |
| Animate | *person, place or thing* |
| Here | *here and there; this and that* |
| Now | *now and then; sooner or later* |
| Agentive | *cat and mouse; hunter and hunted* |
| Patriotic | *Cowboys and Indians; the Dartmouth–Harvard/ Harvard–Dartmouth game* (depending on the speaker's alma mater) |

Such semantic features are determinants in most irreversible conjoined phrases displaying marked semantic differences between their constituent members. Interestingly, Ross (Note 1) has found some of these constraints apparently active in languages other than English, although as yet there are no exhaustive or definitive studies to support a universal application of the "Me First" principle.

The absence of semantic considerations in many freezes naturally raises the question of sound. Why does *stuff and nonsense* sound better than *nonsense and stuff*? Why *mumbo-jumbo, hem and haw, helter-skelter*, and so on, but not their order-reversed counterparts? Seven phonological constraints on such semantics-independent freezing have been proposed by Cooper and Ross (1975), and are reproduced with examples in Table 1. Their list incorporates and distills most of the findings of the literature prior to 1975, while making original contributions as well. These constraints are listed by Cooper and Ross in rough descending order of their strengths in "tugs of war" with one another: When two principles are applicable in a single freeze, but

TABLE 1
PHONOLOGICAL CONSTRAINTS ON FREEZING AS PROPOSED BY COOPER AND ROSS (1975)

| Constraint | First element will have | Second element will have | Examples |
|---|---|---|---|
| (1) Number of syllables (Panini's Law) | Fewer syllables | More syllables | *kit and caboodle*<br>*stuff and nonsense* |
| (2) Vowel length | Short vowels | Long vowels | *stress and strain* |
| (3) Number of initial consonants | Fewer initial consonants | More initial consonants | *helter-skelter*<br>*fair and square* |
| (4) Quality of initial consonant[a] | Less obstruent (more sonorant) initial consonant | More obstruent (less sonorant) initial consonant | *huff and puff*<br>*namby-pamby* |
| (5) Vowel quality[b] | More closed or more front vowel | More open or more back vowel | *dribs and drabs*<br>*flip-flop* |
| | (Decreasing second formant frequency) | | |
| (6) Number of final consonants | More final consonants | Fewer final consonants | *betwixt and between* |
| (7) Quality of final consonant | More obstruent (less sonorant) final consonant | Less obstruent (more sonorant) final consonant | *kith and kin*<br>*push and pull* |

[a] Consonants are ordered from least to most obstruent as follows:
h < Glides < Liquids < Nasals < Spirants < Stops
ẇ,y l,r m,n f,v,s,z,th,sh p,b,t,d,k,g.

[b] Vowels are ordered from highest to lowest second formant frequency as follows:
/i/ > /ɪ/ > /ɛ/ > /æ/ > /ɑ/ > /ʊ̈/ ≈ /ɔ/ ≈ /u/.

they dictate different word orders, the principle that is consistent with the actual word order is said to be stronger than the other one. Thus in *boots and saddles*, the Law of Syllable Number (often called Panini's Law after the 4th Century B.C. Sanskrit linguist who first formulated it) tugs with the Vowel Length rule, but the former wins out and is therefore considered stronger. (Cooper and Ross point out, however, that their hierarchy is based on incomplete evidence.)

Other related research summons scores of extant examples from diverse languages in support of Panini's Law (Jespersen, 1972; Bolinger, 1962; Behaghel, 1909; Morawski, 1927; Malkiel, 1968; Scott, 1913; Abraham, 1950), and, to a degree, in support of the final consonant quality rule (Bolinger, 1962) and the initial consonant quality rule (Morawski, 1927; however, cf. Campbell & Anderson, 1976). The literature also lends firm support to the near-universal application of a vowel rule related to the second formant rule of Cooper and Ross. However, the rule is generally formulated in terms of a high-vowel/low-vowel alternation; that is, taking account of the frequency not of the second formant but of the first, whose frequency varies inversely with vowel height (Jespersen, 1942; Abraham, 1950; Marchand, 1969; Cutler & Cooper, 1978). The orderings of vowels dictated by the two criteria differ as follows: in terms of decreasing second formant frequency, the ordering is (Ladefoged, 1975):

/i/, /ɪ/, /ɛ/, /æ/, /ɑ/, /ʊ/, /ɔ/, and /u/;

in terms of increasing first formant frequency, the ordering is (Ladefoged, 1975):

/i/, /u/, /ɪ/, /ʊ/, /ɛ/, /ɔ/, /æ/, and /ɑ/.

Recently there have been a number of claims concerning the functional significance of principles of frozen word order: for example, that the principles facilitate the processing of information in speech comprehension (Cooper & Ross, 1975; Cutler & Cooper, 1978), that they are suggestive of the "conceptual space" of the speaker (Ross, Note 2); that they constitute an example of "phonetic symbolism" (Tanz, 1971; cf. Brown, 1958; Diffloth, 1972); or that they reflect the "markedness" of semantic dimensions (Cooper & Ross, 1975; cf. Clark, Carpenter, & Just, 1973). Accordingly, we see the need for experimental evidence to corroborate existing linguistic (lexical) evidence, i.e., the set of freezes found in a given language corpus.

First, we wanted to demonstrate the "psychological reality" of Cooper and Ross-type phonological principles which mandate word order. If, for example, we can demonstrate that naive speakers consistently indicate that nonsense paired terms ordered according to the dictates of a given principle "sound better" than the same terms ordered otherwise, we will have evidence for a mechanism in part responsible for the speakers' "feel for" a language. Such a mechanism has been implicated by Campbell and Anderson (1976) and by Cooper and Ross (1975) in the formation of freezes, according to an analogy with Darwinian evolution: Those conjoined phrases in everyday discourse that "sound right" (that conform to the principles) are most likely to "survive" and become conventional in the language. Evidence for such a mechanism would support the Darwinian metaphor and rule out the possibility that freezes came into being through historical or accidental factors.

A second goal is to ascertain the universality of a given principle.[1] To the extent that Rule X is universal, we hypothesize that subjects should consistently prefer the specified order of items in nonsense pairs varying minimally according to Rule X, regardless of the subjects' knowledge of or familiarity with the language upon whose phonetic system the

[1] Some languages (e.g., Yiddish, Hindi, Turkish) seem to invert systematically some or all of the phonological rules, and isolated exceptions to the rules appear in a number of languages. Thus "universal" as employed henceforth should be taken to mean "near universal."

TABLE 2
TYPES AND DEGREES OF EVIDENCE FOR PHONOLOGICAL RULES OF FROZEN WORD ORDER

| Rule | Cross-linguistic evidence | English examples | Literature |
|---|---|---|---|
| Panini's law | Strong | Many, mostly irreversible polynomials | Cited most often |
| Vowel quality | Strong | Many, all types | Cited often |
| Vowel length | Weak, but may be an extension of Panini's Law | Few, but has been found to override semantic rules | Cited only in Cooper and Ross (1975) but ranked high |
| Initial consonant obstruency | Moderate, but inconsistent | Many, esp. reduplicatives; but many counter-examples | Cited often |
| Number of final consonants | ? | No existing minimally contrasting examples | Cited only in Cooper and Ross (1975) |

nonsense words are based. A cross-linguistic test, fashioned similarly, should provide corroborating evidence for universality. A related goal is to determine a ranking of phonological principles, from strong, universal ones to weak and/or language specific ones, based on unconfounded evidence. Since a multiplicity of semantic and phonological factors may be at work in most English freezes, it is often impossible for investigators to decide among differing characterizations of rules or to ascertain their relative strengths. However, with a set of minimally contrasting nonsense pairs, determining factors can be teased apart.

Accordingly, we selected five of the phonological principles for testing, predicting a strength/universality ranking based on three criteria: cross-linguistic evidence for a given principle; actual numbers of unconfounded lexicalized English freezes governed by a given principle; and discussion in the literature we have cited. This ordering and its supporting evidence are summarized in Table 2.

## EXPERIMENT I

### *Subjects*

Forty-eight adults, most with some college education, participated in the experiment. Sixteen were native speakers of English; 16 had just begun their study of English and were rated by their English teachers at 1 to 1.5 on a 5-point scale of fluency; 16 were at the intermediate level and scored 3 to 4 out of 5 on the fluency scale. Subjects from the latter two groups were enrolled in English as a Second Language programs at Harvard and Boston University Summer Schools, or were regular students at the International Institute in Boston, a second-language instruction institution.[2]

### *Materials*

The 50-item questionnaire was composed of 10 nonsense exemplars varying minimally according to each of the five chosen principles, and obeying the sound patterns of English. Care was taken to avoid items reminiscent of existing lexicalized freezes. The first 25 exemplars were placed at the ends of plausible sentences, while the last 25 were presented in

[2] Native languages of beginners were as follows: Spanish (6 subjects); Japanese (4); Chinese, Persian, Hebrew, Korean, Arabic, Portuguese (1 each). Native languages of intermediates were: Spanish (4); Italian (3); French (2); Vietnamese, Japanese, German, Swiss-German, Basque, Yiddish, Armenian (1 each).

isolation. Some examples are listed below for each principle.

Panini's Law

The falling Martian tumbled PLUP over GEPLUP.
My car is so old that it goes BOOF and KABOOF.
DILK or SPLADILK.
DABIG and DADABIG.

Vowel Quality

In baseball games I am an uncoordinated FIM–FUM.
The wet cereal was all GLIGY and GLAGY.
FELACKERY and FELOCKERY.
REPPO and ROPPO.

Vowel Length

All the game consisted of was MOTCHING and MOATCHING.
Before going to bed, most men remove their SMATS and SMATES.
BRETS or BRAITS.
FRINNING and FREENING.

Initial Consonant Obstruency

My lover looked at me and tenderly kissed my WAF–PAF.
I wouldn't have asked you if I'd known you would do it all RASBY and DASBY.
LESH–GESH.
HAIPO and DAIPO.

Number of Final Consonants

The dead man was found lying BEGROAST and BEGROAT.
That radical new theory was merely SWIRP and SWIRR.
FLARD and FLAR.
SKALK and SKALL.

Sentences were presented as follows:

The wet cereal was all { GLAGY and GLIGY. / GLIGY and GLAGY. }

(A) GLAGY and GLIGY — GLIGY and GLAGY (B)

A a ? b B

Exemplars of the different principles were randomly scattered throughout the questionnaire, and the order of terms in each exemplar was counterbalanced across subjects within each proficiency group.

*Procedure*

Subjects were asked to listen to a native speaker's recorded reading of the test while reading silently along on their questionnaires (subvocalizing was also permitted). Detailed instructions as well as practice examples were provided until it was certain that each subject understood completely the procedure. Testing took place in small groups or individually, under good-to-excellent acoustic conditions.

*Results and Discussion*

Mean ratings of the different classes of items by different groups of subjects are illustrated in Figure 1. Means above 3.0 indicate preference for the order dictated by the appropriate phonological principle, means near 3.0 indicate indifference, and means below 3.0 indicate preference for the order contrary to the one dictated by the appropriate principle. The principles are placed along the abscissa in order of decreasing predicted strength. Filled circles represent means that are significantly different from 3.0 ($p<.05$, two-tailed $t$ test) when measured against both subject and item variability; half-filled circles represent means that are significantly different from 3.0 when measured against subject variability only (*left* half filled) or item variability only (*right* half filled).

As is evident from the graph, speakers with greater proficiency in English are more likely, on the average, to rate items in the direction dictated by the phonological principles, $F'(2,51)=7.87$, $p<.005$. The phonological principles themselves are differentially effective in guiding subjects' judgments, with mean ratings tending to decline monotonically according to our proposed hierarchy outlined in the introduction, $F'(4,63)=12.95$, $p<.001$. There is also a tendency for the Native Speakers to obey two principles (Vowel Length and Initial Consonant Obstruency) to which the other groups are indifferent, and for

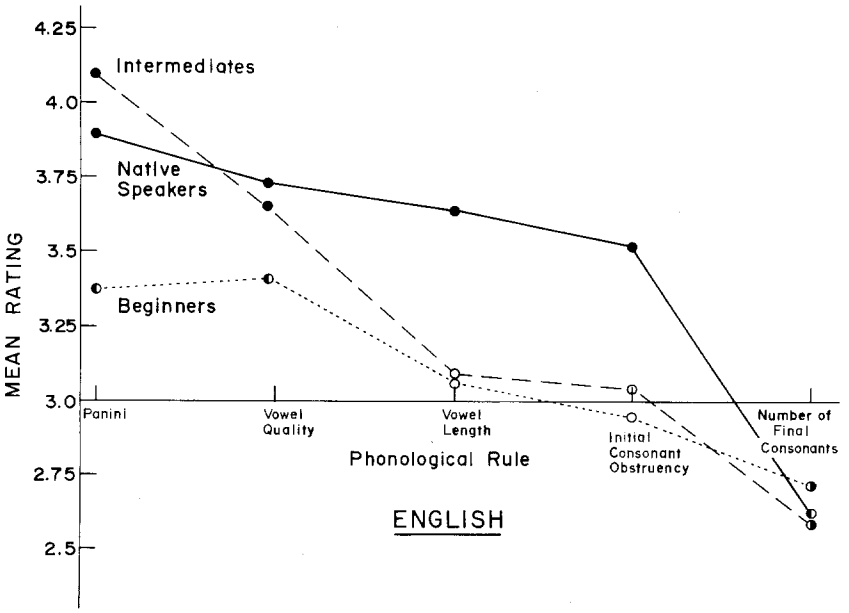


FIG. 1. Mean ratings of order preference of English nonsense pairs.

all three groups to agree on the remaining three principles (Panini's Law, Vowel Quality, Number of Final Consonants). The Proficiency × Principle interaction encompassing this tendency is statistically significant over subjects, $F_1(8,180)=2.32$, $p<.05$, and over items, $F_2(8,90)=2.48$, $p<.05$, and marginally significant over the two simultaneously, $F'(8,110)=1.78$, $p<.10$.

The results are consistent with the predictions based on the linguistic evidence cited in the introduction. The two principles for which claims of universality or near-universality have been made (Panini's Law and Vowel Quality) are respected to various degrees by Beginning, Intermediate, and Native speakers of English, while the principles supported mainly with examples from English, i.e., Vowel Length and Initial Consonant Obstruency, are respected only by Native speakers. Finally, the principle with the shakiest linguistic support, Number of Final Consonants, is *dis*obeyed by all three groups, although none consistently enough to be statistically different from neutrality as measured both over subjects and over items. This reversal, interestingly, would be predicted by a more general phonological principle (encompassing Panini's Law, Vowel Length, and Number of Initial and Final Consonants) which would place the term with less phonetic content first (cf. Cooper & Ross, 1975).

Before making claims about the possible universality or language-specificity of the various phonological principles or their psychological counterparts, we must consider several alternative explanations for our data, especially for the finding that the putatively universal principles were obeyed by all subjects, while the putatively English-specific principles were obeyed only by the Native English speakers. First of all, it is possible that the main effect of Language Proficiency in our data simply indicates that people are more conservative when rating materials from an unfamiliar language. Similarly, the interaction of Proficiency and Phonological Principle could reflect the Beginners' and Intermediates' tendency to cluster about the indifference

point on their rating scales unless their intuitions one way or another were overpowering, possibly masking a weak but nonetheless genuine tendency to react in accordance with the Vowel Length and Initial Consonant Obstruency principles. Second, the Native English speakers may have rated the exemplars of the putatively English-specific principles more highly simply because they were able to discriminate phonemes (or rather their phonetic realizations) that the less proficient speakers could not, such as /I/ versus /i/. Or perhaps the differences between phonemes, although detectable by all, were more salient for the English speakers, because, say, they were farther apart in the speakers' acoustic-phonetic "space." Finally, it is possible that learners of English as a second or foreign language acquire the "strong" freezing principles for English expressions extremely quickly, and the "weaker" ones later, but would be indifferent to *all* these principles if applied to their own languages. A second experiment was designed to attempt to weaken the credibility of these alternative accounts.

## Experiment II

The alternative explanations of the results of Experiment I are all based on one contingency: the confounding of knowledge of English per se with familiarity with the sound pattern of the items to be rated. An appropriate control experiment would use items respecting the sound patterns of a different language, and raters with varying degrees of familiarity with that language, including native English speakers. If the Panini and Vowel Quality principles are in fact universal, we would again expect all groups of subjects to rate exemplars in the appropriate direction. Also, if our results from English stimuli are generalizable, we would expect all groups to *violate* the Number of Final Consonants principle in their judgments. Finally, if the Vowel Length and Initial Consonant Obstruency principles are rules one acquires when learning English, we would expect native speakers of the control language to be indifferent to the exemplars. Meanwhile native English speakers learning the control language would choose the appropriate ordering (assuming they applied their knowledge of the principles to the novel language), though possibly at an attenuated level owing to their unfamiliarity with the sound pattern of the items.

### *Subjects*

Forty-two adults, all with some college education, participated: 14 beginners, all native English speakers, who had just completed an elementary intensive French course at Harvard Summer School; 14 native English speakers who had just completed an intensive intermediate course at the Summer School; and 14 who were native speakers of French.

### *Materials*

The questionnaire was parallel to that of Experiment I, with the exception that the exemplars devised were based on the sound system of French. Similarly, the first 25 exemplars were placed at the ends of plausible French sentences, the rest in isolation. Typical French exemplars are listed below.

Panini's Law

Ils ont gagné le match en GISSANT et en ÉGISSANT.
S'il vous plaît, passez-moi le PARCHE et le PARCHELOT.
le VELI et le VELINOCHET.
avec DABIGUE et DABIGUEMAIN.

Vowel Quality

Charles de Gaulle se plaisait à répéter, "à bon PÈQUE, bon POQUE."
J'en ai assez de ton RIQUE–RAQUE.
la DURMISSE et la DURMOUSSE.
MUCHE–MACHE.

Vowel Length

Au parc on s'amuse à regarder le PORET et la PORÉE.

On est partis en vacances, sans TRUSE ni TRUSSE.
le FREDOT et le FREDÔME.
la LETTE ou la LÊTE.

Initial Consonant Obstruency
Ils se battaient à RANTON–BANTON.
Si on commençait une partie de HUPIN–TUPIN?
RÈCHE–GUÈCHE.
LURIBLE et PURIBLE.

Number of Final Consonants
On lui a coupé les STERMES et les STERDS.
Il ne faut pas chasser avec FLARQUE et FLARD.
avec PRÉMISTE et PRÉMISSE.
le SITUBORQUE et le SITUBORG.

*Procedure*

The procedure in Experiment II was identical to that of Experiment I. However, directions were given in the native language (English or French) of the individual subjects.

*Results and Discussion*

Mean ratings are displayed in Figure 2. As in Experiment I, mean ratings decrease monotonically from the strongest to the weakest phonological principle, and accordingly the main effect of Principle is statistically significant, $F'(4,57)=13.79$, $p<.001$. There is no main effect of language Proficiency, however, the means for the three groups being virtually identical, $F'<1$. Nevertheless the interaction between Proficiency and Principle is statistically significant, $F'(8,100)=2.55$, $p<.05$. The most salient trend encompassed by this interaction is a tendency for the more proficient speakers to be more extreme in their judgments, whether obeying a phonological principle (Panini's Law, Vowel Quality) or disobeying it (Number of Final Consonants). The same trend is observable in the data from Experiment I, and when the results from the two experiments are combined in a three-way Analysis of Variance (dropping two subjects at random from each English group to obtain

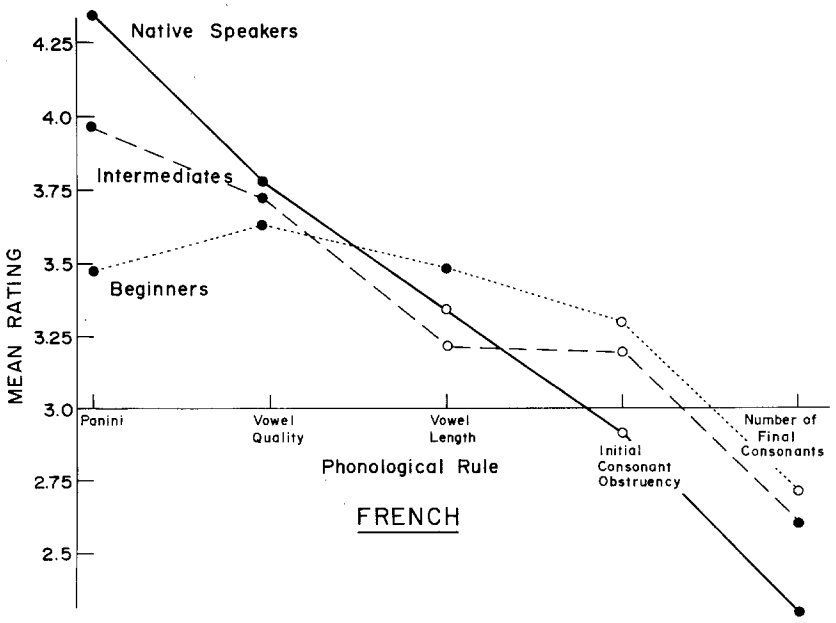


FIG. 2. Mean ratings of order preference of French nonsense pairs.

equal sample sizes) the Proficiency × Principle interaction is significant, $F'(8,211)=2.25$, $p<.05$. It therefore seems likely that subjects' judgments one way or another do tend to be more extreme when they rate material whose sound pattern is familiar to them.

However, the main conclusions from Experiment I are still tenable to varying degrees. Again the Panini and Vowel Quality principles are obeyed by all three groups, and the Number of Final Consonants principle is disobeyed by all three, although here at a statistically significant level only by the more advanced groups. In contrast, we find that the pattern of ratings for the Vowel Length and Initial Consonant principles seems to reverse that of Experiment I. In that experiment the Native Speakers were the only ones to rate these items above chance; in the present experiment the curves for the different groups cross over, indicating that the Beginning and Intermediate speakers of French obey the principles to a greater degree than do the Native Speakers, despite their general tendency to rate items more conservatively. Of course the reversal is only superficial: the Beginning and Intermediate speakers here are all native English speakers, and the greater conformity of their judgments to the two principles may mean that these principles are English-specific. Combining the Beginning and Intermediate groups (i.e., the Native English speakers), we find that the Vowel Length exemplars are rated significantly above chance, $t_1\ (27)=3.23$, $p<.005$ for subjects; $t_2(9)=4.67$, $p<.005$ for items. However, the preferences for the Initial Consonant Obstruency exemplars were not strong enough to be significant over both subjects and items; $t_1(27)=2.43$, $p<.025$ for subjects; $t_2(9)=1.25$, $p>.10$ for items.[3]

Thus the same overall pattern emerged in both experiments: native English speakers respect the Vowel Length and Initial Consonant Obstruency principles to a greater extent than do native speakers of other languages, regardless of familiarity with the sound pattern of the test items. However, this conclusion must be accompanied by some caution, since the French Native speakers did rate the Vowel Length exemplars in accordance with that principle, though not significantly above chance, and since the English native speakers (French Beginners and Intermediates) did not rate the Initial Consonant Obstruency items significantly above chance over items.

## General Discussion

The most important finding in the present investigation is the general agreement of speakers' judgments of which is the "better" order for a pair of nonsense words with the order dictated by principles as derived from linguistic, or lexical, evidence. In particular, the principles for which exemplars exist in a number of languages, i.e., Panini's Law and Vowel Quality, seem to guide the ratings of all our subjects, largely independent of the subjects' native languages or their familiarity with the sound patterns on which the items are fashioned. The principles for which evidence

[3] It is difficult to construct realistic French items varying minimally according to vowel length, since a chief determinant of the length of a vowel is whether or not a consonant follows it. Unfortunately six out of our 10 French Vowel Length exemplars are confounded in this way; hence we performed a separate analysis using only the four items that were minimal or near-minimal pairs, and obtained virtually identical results. The mean for the Beginners was 3.48, unchanged from the complete analysis, and still significantly above chance, $t_1(13)=3.56$, $p<.01$; $t_2(3)=5.50$, $p<.02$. The means for the Intermediates and Natives were 3.06 and 3.14, respectively, compared to 3.21 and 3.34 with all items. The combined mean for the Beginners and Intermediates is significantly above chance over subjects, $t_1(27)=2.55$, $p<.02$, and marginally above chance over items, $t_2(3)=2.8$, $p<.10$. In addition, three out of our 10 French Initial Consonant Obstruency items did not vary minimally, but confounded consonant obstruency with number of consonants. Omitting these items also leaves the means and significance levels virtually unchanged: 3.26, 3.32, and 2.91 compared with the original 3.30, 3.20, and 2.92 for the Beginners, Intermediates, and Natives, respectively.

exists mainly in English, i.e., Vowel Length and Initial Consonant Obstruency, seem to guide the ratings of the native English speakers only. And the one principle for which little evidence exists in English or in any other language, Number of Final Consonants, seems to guide all our subjects, but in the wrong direction. In fact, we have since learned (Ross, Note 3) that an unconfounded counterexample to this principle has been found in Arabic, thus strengthening our assertion that speakers' ratings parallel linguistic evidence.

These findings suggest that ratings of minimally contrasting nonsense pairs are an ideal form of evidence for assessing the potency of principles of frozen word order in those cases where the linguistic evidence is equivocal owing to a lack of unconfounded examples. It also supports the notion that the formation and maintenance of freezes (and perhaps of other idioms) are mediated by speakers' intuitions that certain word combinations sound better than others. If indeed there exist among speakers certain selection pressures which work to preserve some word combinations and to weed out others, it is evident from our study that speaker intuitions do act discriminatingly to conform to the phonological principles which uphold, rather than violate, the linguistic status quo.

Before we turn to the possible psychological function of such intuitions, it is necessary to examine whether we have stated the correct phonetic descriptions for the patterns of preferences we have observed. As mentioned before, vowels in the first element of a freeze tend to have higher second formant frequencies, lower first formant frequencies (i.e., are "higher" vowels), and, additionally, greater differences between their first and second formant frequencies (roughly, farther "front"). Although Cooper and Ross (1975) stated the Vowel Quality principle in terms of the second formant frequency, we feel the first formant frequency, or high–low dimension, may be a better specification. First of all, several exceptions to the second formant rule, e.g., *oohs and ahs*, are predicted by the first formant rule. Second, for the 10 Vowel Quality items in our English questionnaire, the difference between the first formant frequencies of the two elements correlates significantly with the order judgments of the native English speakers, Spearman's $rho = .61$, $t(8) = 2.18$, $p < .05$ one-tailed. On the other hand, differences between the second formant frequencies of the first and second elements (Cooper & Ross's specification) correlate poorly and in a negative direction with subjects' ratings, $rho = -.34$. Furthermore, when the difference between the first and second formant frequencies (generally acknowledged as the best numerical measure of vowel frontness) of the second element is subtracted from the corresponding formant frequency difference of the first element, the correlation with ratings is once more small, $rho = .21$. Since most vowels in English and other languages at least partially confound height and frontness, however, it would seem that neither of the vowel quality formulations can be replaced by the other; perhaps then the "best" vowel pattern in a freeze would alternate a high, front vowel with a low, back one. Indeed, Tanz (1971) has found that in eight languages, the words for "here" are higher and/or farther forward than the words for "there." Swadesh (1971) has found the same to hold for terms for "this" and "that" in unrelated languages.

Panini's principle also admits of other descriptions. Anderson (Note 4) and Jespersen (1972) point out that Panini's Law has the effect of giving freezes patterns of stressed syllables agreeing with the patterns that hold for English phrases and words in general. For example, our BOÒF aňd KĂBOÓF may be preferred to KĂBOÒF aňd BOÓF merely because the *rhythm* of the former ordering follows the same rhythm pattern as "heàd ŏvĕr heéls," "nèvĕr săy díe," "hàmmĕr aňd tóngs," and many others. The fact that there are fewer syllables before the word "and" than after it is irrelevant, according to this analysis. In fact, Campbell

and Anderson (1976) point out that conformity to rhythm patterns will often yield freezes that place *more* syllables before item boundaries than after, e.g., *bibbety-bobbety-boo*, *blankety-blank*, *hippety-hop*. Notwithstanding, although it seems clear that English speakers do not shelve their appreciation of the rhythms of the language when creating or judging freezes, our data indicate that Panini's Law is not simply an artifact of stress patterns. First of all, in Experiment II, the French Native speakers preferred the order of French-sounding items that Panini's Law dictated, even though the stress patterns that Campbell and Anderson discuss do not apply to French, which, unlike English, is a syllable-timed language. Second, at least two of our items in Experiment I obey English rhythm patterns in *either* order: PLÙP ôvĕr GĔPLÚP sounds like "snàp, crâcklĕ, ănd póp," "màn, wômăn, ănd chíld," etc.; GĔPLÚP ŏvĕr PLÙP sounds like "ădvìce aňd cŏnsént," "thĕ goòd aňd thĕ bád," etc. Similarly, SPRÌSS ănd SPRÍSSNĬCK sounds like "breàd ănd búttĕr"and "èvĕn Stévĕn" whereas SPRÌSSNĬCK ănd SPRÍSS sounds like "hàmmĕr ănd tóngs" and "nèvĕr săy díe." Nevertheless, in both cases the English Native Speakers preferred the order of terms that Panini's Law dictates. Their mean ratings for the two items were 4.31 and 4.00, significantly above indifference in both cases, $t(15)=4.20$, $p<.001$; and $t(15)=2.51$, $p<.05$, two-tailed.

Finally, we wish to point out a possible psychological function of the rules of frozen word order, reiterating arguments made by Cooper and Ross (1975) and by Cutler and Cooper (1978), who suggest that the phonological rules aid speech perception. Presumably it is more of a strain on the human speech processing system to encode items at the beginning of a phrase, when new material is coming in concurrently, than items at the end of a phrase, after which a break or pause typically follows. Indeed, there is evidence that people choose to place longer material at the ends of sentences or phrases: Bever (1970) notes that complex noun phrases are usually shifted to the ends of sentences, and Cooper (Note 5) has found that words spoken at ends of phrases have longer durations, regardless of their internal structure. There is also evidence that the ends of words are easier to attend to: Slobin (1973) has found that children universally learn inflections at ends of words more quickly than those at beginnings of words, holding meaning constant. Finally, there is evidence of a more direct sort: Cutler and Cooper (1978) showed that people are faster to detect phonemes embedded in a syllable when a pair of elements is presented in the order dictated by Panini's Law than when it is presented in the opposite order. Cooper and Ross could claim that three out of their seven phonological principles (Panini's Law, Vowel Length, and Initial Consonant Number) yield expressions with the longest or phonetically "heaviest" item (and hence, presumably the item most difficult to encode or retain) at the end of the expression, where they would be easiest to process. Happily, our data suggest that the Number of Final Consonants principle should be restated so that it too conforms with this tendency, thus dictating *fewer*, not more, final consonants in the initial term of a freeze. The more general principle, noted by Cooper and Ross, which states that earlier elements in a frozen expression should have less phonetic content, would then be a strong candidate for universality, supported by linguistic and behavioral evidence and by a theory of its cognitive function.

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