Emergent positional privilege in novel English blends

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Abstract

We present evidence from experiments on novel blend formation showing that adult English speakers have access to constraints that give phonological privilege to HEADS, NOUNS, and PROPER NOUNS, even though the non-blend phonology provides no evidence that such constraints are generally active in the grammar of English. Our results (a) demonstrate that these positional constraints are universally available; (b) confirm that the lexical category 'proper noun' has the status of a strong position, which has broader implications for the role of lexical categories in positional-privilege effects; and (c) confirm that strong positions based on salience from non-phonetic sources (such as morphosyntactic, semantic, or psycholinguistic salience) participate in position-specific phonological phenomena.*

Keywords: lexical blends, positional neutralization, emergent effects, lexical categories, category-specific phonology, noun faithfulness, prominent positions

1. INTRODUCTION. POSITIONAL NEUTRALIZATION EFFECTS are a class of phonological phenomena in which contrasts are neutralized in 'weak' positions such as unstressed syllables or coda consonants, but maintained in 'strong' positions such as stressed syllables or onset consonants. These effects are common in the world's languages, and very similar sets of strong and weak positions recur across languages. However, there is some controversy over the best phonological account of these typological facts—in particular, over whether they arise from the UNIVERSAL availability of constraints specifically enforcing phonological PRIVILEGE in strong positions.

The earliest approaches to positional neutralization in the Optimality Theory framework (e.g. Beckman 1997, 1999; Casali 1996, 1997; Zoll 1996, 2004) assumed or explicitly proposed that constraints referring to members of a particular inventory of strong (or weak) positions are part of an innate universal constraint set. As with all constraints in classic OT (Prince & Smolensky 1993/2004), particular positional constraints might or might not be ranked high enough in any given language to have observable effects on surface phonological patterns, but on this view, all positional constraints are part of the phonological grammar of all speakers.

Subsequent proposals in phonological theory have, however, made possible an alternative conception of positional neutralization, in which neither a universal set of designated privileged positions, nor a universal inventory of constraints (positional or otherwise), must be encoded in the phonological grammar. First, it has been proposed that the reason why some phonological positions are typologically more resistant to neutralization is that they are PHONETICALLY better able to support contrasts; this leads to a lower likelihood of PHONOLOGICAL neutralization of contrasts than in non-salient contexts, because the salient contexts are less susceptible to misperception and reanalysis during diachronic transmission (Kochetov 2002, 2003; Jonathan Barnes 2006; on phonetically-guided sound change, see reviews in Hansson 2008 and Garrett & Johnson 2013). For example, in languages where stressed syllables have greater duration than unstressed syllables, there is more time for articulatory vowel targets to be reached in stressed syllables. This makes them less vulnerable than unstressed syllables to articulatory undershoot, and thus to diachronic reanalysis as undergoing phonological vowel reduction. On this view, it is not necessary to assume that the universal phonological grammar designates 'stressed syllable' as a strong position with a corresponding set of OT constraints explicitly enforcing greater phonological privilege in this position, while crucially disallowing the same treatment of the position ‘unstressed syllable’. This is because even if the constraint set proper can refer in exactly the same way to ‘stressed syllable’ (a strong position) and ‘unstressed syllable’ (a weak position), only those constraints giving rise to stressed-syllable privilege will ever receive the kinds of phonetic or diachronic support that cause language learners to rank them high enough in the grammar to be active in surface phonological patterns.

Second, it has been called into question whether there is a universal set of constraints in the first place. Instead, perhaps each learner induces a particular set of constraints on the basis of patterns encountered in the ambient language data during the course of acquisition (Hayes & Wilson 2008; see also Coleman & Pierrehumbert 1997 for a related approach). On this non-universalist view of constraints, speakers of languages without positional neutralization patterns would not have induced positional constraints when acquiring their phonology, and so would never be expected to show the effects of such constraints when their phonological grammar is probed. On the strongest interpretation of this model, even a learner that induces one particular positional constraint on the basis of patterns in the data would not necessarily induce other positional constraints, not even other constraints relativized to that same position.

Thus, it is an empirical question whether access to constraints enforcing positional privilege in strong positions is universally available to all (adult) speakers or whether knowledge of such constraints only comes about through exposure to relevant patterns of positional privilege in the ambient language data.

In this paper, we present evidence from EMERGENT EFFECTS in NOVEL BLEND FORMATION to show that several classes of positional constraints that are active in the grammars of languages other than English, but play no role in English phonology, nevertheless influence English speakers’ performance in a blend-to-definition matching task (Shaw 2013, Shaw et al. 2014). We begin by replicating Shaw’s demonstration of emergent positional privilege for MORPHOLOGICAL HEADS (versus nonheads), then extend the investigation to two more typologically motivated non-phonetic strong positions, NOUNS (versus verbs) and PROPER NOUNS (versus common nouns). As discussed below, there is no evidence from the phonological grammar of English in support of constraints enforcing positional privilege specific to these positions, so adult speakers of English cannot be using such constraints in novel blend formation unless they are in fact universally available.

This paper is organized as follows. Section 2 sets the theoretical and empirical stage with the principal themes of this study: positional privilege, emergent phonological effects, and lexical blends. Section 3 focuses on the particular varieties of positional privilege studied here and lays out crosslinguistic evidence that segments and stress belonging to morphosemantic heads, to nouns, and to proper nouns can resist phonological processes that apply elsewhere. The experiments (which are all systematic variations on the same theme) are motivated and described in Section 4; results are reported in Section 5. Finally, in Section 6, we consider possible sources and implications of these emergent effects of positional privilege.

2. POSITIONAL PRIVILEGE, EMERGENCE, AND LEXICAL BLENDS. This section outlines the theoretical background concerning positional privilege, emergent phonological effects, and the relevance of lexical blends to these questions of phonological theory.

2.1. POSITIONAL PRIVILEGE AS POSITIONAL FAITHFULNESS. Many languages are subject to a phonological phenomenon known as POSITIONAL NEUTRALIZATION, in which certain phonological processes, such as obstruent devoicing or vowel reduction, occur only in particular structural positions, such as syllable codas or unstressed syllables (see Trubetzkoy 1939/1969:235–6 for early discussion). From the perspective of a constraint-based approach to phonology such as Optimality Theory (Prince & Smolensky 1993/2004), the neutralization of a phonological contrast means that MARKEDNESS CONSTRAINTS, which impose phonological requirements on output (surface) forms, dominate FAITHFULNESS CONSTRAINTS, which require output forms to preserve the phonological characteristics of their corresponding input (underlying) forms. Conversely, failure to undergo some potential neutralization process shows that the reverse ranking or weighting, in which faithfulness constraints dominate markedness constraints, holds in the language. The case of positional neutralization is therefore particularly interesting, because in order for a neutralization process to occur only in some position, the constraints pertaining to that position must be in a markedness >> faithfulness relationship, while the constraints pertaining to material outside that position must be in a faithfulness >> markedness relationship.

Formally, this insight has been implemented by creating special position-specific versions of constraints, such that they are in force only for phonological material that falls within particular positions. In the POSITIONAL FAITHFULNESS approach (Beckman 1997, 1999; Casali 1996, 1997), faithfulness constraints have position-specific counterparts that can be ranked high to protect phonological material in the PRIVILEGED or NON-NEUTRALIZING positions. For example, a ranking such as IDENT[voice](Onset) >> *VOICEDOBSTRUENT >> IDENT[voice] protects voiced obstruents in syllable onsets from devoicing, because IDENT[voice]-Onset dominates *VOICEDOBSTRUENT. However, voiced obstruents in syllable codas are not protected by the high-ranking onset-specific faithfulness constraint, and so they fall prey to the *VOICEDOBSTRUENT >> IDENT[voice] ranking and undergo devoicing.

An alternative approach is POSITIONAL MARKEDNESS (Zoll 1996, 1998, 2004; Steriade 1999), in which it is markedness constraints that are position-specific, and these specifically penalize marked structures that occur in the NEUTRALIZING or NON-PRIVILEGED positions. To account for coda voicing neutralization, this approach would invoke a positional markedness constraint COINCIDE(VoicedObstruent, Onset), which is violated by any voiced obstruent that is not in onset position, and rank it above IDENT[voice] so that faithfulness cannot protect voiced obstruents in codas. With IDENT[voice] ranked above a general *VOICEDOBSTRUENT constraint, however, voiced obstruents in onsets would still be protected.

For our formal implementation of positional privilege, we choose positional faithfulness. Although some phonological phenomena are equally amenable to a positional markedness or a positional faithfulness treatment, the effects that our experiments investigate—namely, segmental preservation and stress preservation in strong positions—raise problems for the positional markedness approach, as first noted in Shaw et al. (2014). First, the initial argument of a COINCIDE constraint is hypothesized to name a marked structure (voiced obstruents in the example above); part of Zoll's (1998) definition of COINCIDE(*x*, *E*) is a local constraint conjunction involving an existing markedness constraint banning that structure, **x* (*VOICEDOBSTRUENT). But this means that the positional markedness constraints that would be needed to enforce segmental preservation in strong positions, such as COINCIDE(segment, head) for morphosemantic heads (see Section 3.1), presuppose the existence of a constraint *SEGMENT that penalizes all segments. Gouskova (2003) argues against the existence of such ‘nihilistic’ constraints on several empirical and theoretical grounds, including the complex machinery needed to prevent them from ever being undominated. Second, a grammar in which the positional markedness constraint COINCIDE(segment, head) is itself undominated would remove all segments from all morphemes other than heads; undominated COINCIDE(segment, noun) and COINCIDE(segment, proper noun) would likewise wreak typologically unsupported havoc. Finally, even the COINCIDE constraints needed to account for stress preservation in strong positions have bizarre typological consequences. A grammar in which COINCIDE(stress, noun) or COINCIDE(stress, proper noun) were undominated would have stress only on common or proper nouns. By contrast, the Positional Faithfulness constraints proposed here are typologically benign (for example, MAX(proper noun) is undominated in Jordanian Arabic; see discussion in Section 3.3 below). For these reasons, we conclude that the effects observed in both the segmental and the stress experiments are due to positional faithfulness rather than positional markedness.

2.2. EMERGENT RANKINGS AND EMERGENT CONSTRAINTS. The term EMERGENT EFFECT is used in the context of Optimality Theory (Prince & Smolensky 1993/2004) to refer to a situation in which a constraint or a constraint ranking is not usually or generally visible in a language, but reveals itself under particular circumstances. The term originates in the discussion of ‘emergence of the unmarked’ effects by McCarthy and Prince (1994), a class of effects in which a relatively low-ranking markedness constraint becomes visible in a specific context where higher-ranked competing constraints are not relevant. For example, a language might tolerate syllable codas in general, because a faithfulness constraint against deleting input segments (MAX-IO) is ranked high, and yet the same language might avoid codas in reduplicative copying, because MAX-IO does not assign violations when a reduplicant is less than a complete copy of its base. Here, the effects of the relatively low-ranking NOCODA constraint EMERGE in the specific context of reduplicative copying.

Subsequent research has identified cases where constraints or constraint rankings have no discernable effect in first-language (L1) phonology at all, even in specific contexts such as reduplication, but nevertheless display emergent effects when speakers perform non-L1 tasks. Examples include emergent effects in second-language or interlanguage phonology (Broselow, Chen, & Wang 1998; Zhang 2013; Jesney 2014), in laboratory production and perception of non-L1 structures (Davidson 2001, Berent et al. 2007; although see Davidson 2010 for an opposing perspective), in loanword phonology (Jacobs & Gussenhoven 2000; Ito & Mester 2001), and in language games (Moreton, Feng, & Smith 2008). Emergent effects of this sort are theoretically significant because they reveal phonological knowledge that could not have been learned directly from the L1 ambient language data. In this vein, our experiments use novel lexical blends to probe for emergent effects of positional privilege that are not evident in the non-blend phonology of English.

2.3. LEXICAL BLENDS. LEXICAL BLENDING is a word-formation process that combines two or more SOURCE WORDS into a single BLEND, losing some phonological material in the process: *spoon* + *fork* → *spork* (Pound 1914; Wentworth 1934; Algeo 1977; Bat-El 2006; Renner et al. 2012). The term is defined by different authors to encompass a heterogeneous range of processes, but all definitions include *spork*-like words, which begin like Source Word 1 and end like Source Word 2, and we follow Bat-El (2006) in applying 'blend' narrowly to this process. (We are also concerned only with INTENTIONAL blends, not speech errors.) Blends are of interest for our purposes for two main reasons.

First, blending can force a choice of which source word to be unfaithful to. Blend outputs have fewer segments than the source words together, and usually fewer syllables as well (Gries 2004a,b; Bauer 2012), and they cannot have more than one main word stress; thus, *blue* + *green* forces a choice between *bleen* and *breen,* and *mótor* + *hotél* forces a choice between *mótel* and *motél* (Arndt-Lappe & Plag 2013). Much higher levels of unfaithfulness can be obtained through blending than through most other morphological or phonological processes of English; for example, *breakfast* + *lunch* → *brunch* deletes 7 of the source words' original 12 segments, and 2 of the original 3 syllables. The greater magnitude of unfaithfulness available through blending may make it possible to detect effects that would be too faint to see in other contexts, especially if violations add across constraints, as they do in Harmonic Grammar (Legendre, Miyata, & Smolensky 1990; Smolensky & Legendre 2006; Pater 2009).

Second, blending, like a language game or loanword phonology, is a relatively infrequent operation which involves the adaptation by the L1 grammar of something which is consciously felt—and often even intended—to be anomalous (Piñeros 2004; Gries 2012). Blending therefore offers a similar opportunity to observe emergent effects when a grammar which is optimized for L1 phonology is applied in very different circumstances. We know of no way to compare the frequency of blending with that of language games, but studies of neologisms have found blending to be less frequent than borrowing (Algeo 1980; Cannon 1987 via Bauer 1989), and hence less frequent than loanword adaptation. The CELEX lexical database identifies only 59 lemmas as blends out of a sample of 52,447 lemmas (0.11%, using a broader definition of 'blend' than ours), and their summed corpus frequency is 896 in a corpus of 18,580,121 words (0.0048%) (Baayen et al. 1995, fields 3 and 23 of file EML.CD). Blending thus creates an arena in which effects of universal phonological constraints which play no role elsewhere in the grammar can emerge (Bat-El 2000).

Our experiments on emergent effects in lexical blends find strong evidence for two subtypes of phonological positional privilege: privilege for heads and for proper nouns. We also find weaker, but still favorable, evidence for a third subtype, privilege for nouns. These three categories of positional privilege, and our experimental findings concerning their emergent effects in blend formation, are discussed in the sections that follow.

3. POSITIONAL PRIVILEGE FOR MORPHOLOGICAL CATEGORIES. In her survey of positional neutralization effects, Beckman (1997, 1999) draws a distinction between positions that resist neutralization because they are PHONETICALLY salient, including stressed syllables or syllable onsets, and positions that resist neutralization because they are salient for PSYCHOLINGUISTIC reasons, such as their importance in lexical access and language processing; namely, roots (see also McCarthy & Prince 1995) and initial syllables. A similar distinction is drawn by Casali (1996, 1997) between positions that are strong because they have salient phonetic cues, and positions that are strong for morphological or morphosyntactic reasons. In the latter category, Casali discusses mainly lexical morphemes (as opposed to functional or grammatical morphemes), and he makes note of the greater degree of semantic content in lexical morphemes as one possible reason for their status as a salient position. Other proposals for non-phonetically based strong positions include derivational heads (Revithiadou 1999) and nouns (Smith 2001).

In summary, typologically attested strong positions are not always privileged for reasons of greater phonetic salience; some strong positions seem to owe their status to factors including psycholinguistic, morphosyntactic, or semantic salience. This distinction is important because proposals recasting positional neutralization patterns as effects of diachronic transmission (e.g. Kochetov 2002, 2003; Jonathan Barnes 2006) have focused primarily on phonetically strong positions.

The positions we test in our blend experiments all fall into the class of positions that are privileged for morphological or morphosemantic reasons rather than phonetic reasons: heads, nouns, and proper nouns. In this section, we review evidence and theoretical background concerning phonological privilege for these three categories in order to argue first, that the typological facts confirm that each of these positions is indeed a 'strong' position crosslinguistically, and second, that the non-blend phonology of English does not show overt effects of positional privilege for any of them.

3.1. POSITIONAL PRIVILEGE FOR HEADS. As outlined above, the fact that blends require truncation of phonological material can be exploited to test for effects of positional privilege. We begin by reviewing proposals that MORPHOLOGICAL HEAD is one of the privileged positions. Our experiments will confirm this hypothesis by showing that the phonological material from a head (both segmental and prosodic) is more likely to be preserved in a blend than the material from a nonhead.

One of the earliest proposals for positional faithfulness to heads in OT is due to Revithiadou (1999), who proposed it as a possible alternative to positional faithfulness for another morphological position, the root (McCarthy and Prince 1995). Revithiadou's proposal was motivated by data from such languages as Greek and Russian, in which the morphological head was claimed to determine the position of the main stress in derived words (also see Roon 2006).

Ussishkin (1999) adopts Revithiadou's HEADFAITH constraint to explain a segmental rather than a prosodic effect. Namely, he argues that head faithfulness correctly predicts which segments are more likely to be realized in one type of derivational formation in Hebrew, the deverbal nouns restricted to two syllables by a prosodic shape constraint. Thus, head faithfulness has been previously posited to affect both prosodic and segmental content in morphological derivatives. Shaw (2013) tested whether blend formation in English is sensitive to positional privilege effects for heads, and found support for the hypothesis that both the segmental makeup of a novel blend as well as its stress pattern are influenced by its head, although she used a somewhat different definition of head than Revithiadou.

In particular, for Revithiadou the morphological head is defined based on formal, syntactic criteria. However, one can also talk about semantic heads of morphological derivatives. Below we briefly review the difference between these two notions of head, and discuss the criteria we will use for determining heads in blends, which are similar to the criteria used by Shaw.

The morphological analogue of a syntactic head is a morpheme that determines the syntactic category and the morphological class (e.g., gender) of a word, and hence its distribution. In theories in which affixation is accomplished in syntax, derivational morphemes and roots typically function as heads, unlike most inflectional morphemes (although this view is controversial, as discussed in Beard 1998). A different notion is a SEMANTIC HEAD, an element that, roughly speaking, expresses the main meaning of the construction. In morphology, semantic heads are typically appealed to in discussion of compounds. In general, there is greater agreement about what constitutes a head of a compound than there is about heads of other derived words. The most common definition of heads in compounds relies on the semantic relation of hyponymy: if the compound as a whole is a hyponym of one of its members, then that member is the semantic head (Allen 1978). For example, a *sunflower* is a kind of flower, so *sunflower* is a hyponym of *flower*; therefore, *flower* is the semantic head of the compound. One can also apply the formal criterion for headedness to those compounds whose members belong to different lexical categories. In those cases, the member that determines the lexical category of the compound is the syntactic head. However, Guevarra and Scalise (2009) point out that the semantic criterion of headedness is more reliable because the syntactic criterion alone could lead to wrong predictions. For example, in Italian, *rompighiaccio* ('break' + 'ice') 'icebreaker' cannot be analyzed as being headed by the noun *ghiaccio* 'ice' despite having the same syntactic category as 'ice.' They propose that both the syntactic and the semantic criteria for headedness must be satisfied by the head of a compound. Violation of either one of the two criteria qualifies a compound as exocentric (or headless). Because blends, like compounds, involve a combination of several roots or words, and are sometimes considered to be a type of compounding (Bat-El 2006), it is reasonable to treat blends in the same way as compounds with respect to headedness.

Since we are interested in head effects, all of the blends in our experiments are endocentric. That is, they have at least one head that meets both the syntactic and the semantic criteria for headedness. Additionally, we make a distinction between blends that have just one head versus blends that have two heads, following a similar distinction in compounds between endocentric coordinate and endocentric subordinate/attributive compounds (Bisetto & Scalise 2005). A coordinate compound is a compound whose members are semantically connected by the logical connector 'and' (e.g. *bitter-sweet*, *actor-director*). When the meaning of such compounds is compositional, they can be said to have two heads. An example of an analogous coordinate blend is *spork*, something that is both a spoon and a fork. On the other hand, a *motel* (*motor* + *hotel*) is a type of hotel, not a type of motor, and *affluenza* (*affluence* + *influenza*) is metaphorically a type of a disease, not a type of affluence, and not something that is both an affluence and a disease. Thus, *motel* and *affluenza* have just one head, corresponding to the rightmost source word.

As far as we know, no one has previously claimed that phonological privilege for heads affects the phonology of English. If anything, there is some indication from compounds that heads are not privileged when it comes to determining the position of the main stress. It is well known that English endocentric compounds are right-headed, but that the most prominent stress in a compound typically falls on the nonhead (the Compound Stress Rule, Chomsky & Halle 1968).[1]

Thus, based on the evidence from compounds, there are no visible prosodic effects of head privilege in English. We are also not aware of any segmental privilege effects for heads in English. Our blend experiments test for effects of a head-faithfulness constraint against segmental deletion, MAX(Head), and a head-faithfulness constraint against the removal of main word stress, MAXSTRESS(Head). Thus, if we observe special faithfulness to heads in lexical blends, it is reasonable to assume that it was not learned from the lexicon or the ambient non-blend phonology of English.

3.2. POSITIONAL PRIVILEGE FOR NOUNS. A second category of phonological positional privilege that can be probed in novel blend formation is positional privilege for NOUNS (Smith 2001). The phonological behavior of nouns and verbs may differ (see, for example, Cohen 1939/1964; Postal 1968; Kenstowicz & Kisseberth 1977; Myers 2000; Bobalijk 2008). Some noun/verb differences simply involve different default patterns for nouns and verbs (Chomsky & Halle 1968; Lynch 1978; Wolff 1983; Kelly 1992), and therefore do not bear on the question of positional privilege. However, when one of these two categories shows stronger effects of phonological privilege, it is cross-linguistically more likely to be nouns than verbs (Smith 2011).

In our experiments, we test for evidence of adult English speakers' access to a noun-faithfulness constraint against segmental deletion and a noun-faithfulness constraint against the removal of main word stress, MAXSEG-Noun and MAXSTRESS-Noun respectively. We argue that both of these constraints show true emergent effects in English blends, because high rankings for them cannot have been learned from the non-blend phonology of English.

First, English speakers could not have learned a ranking involving MAXSEG-Noun from exposure to English phonology. While it is true that nouns are on average longer than verbs (by syllable count) in English (Cassidy & Kelly 1991), there are no active alternations involving segment deletion that treat nouns and verbs differently. Furthermore, there is no mandatory maximum size for either nouns or verbs. Thus, no evidence is encountered during the acquisition of English for any crucial ranking involving the constraint MAXSEG-Noun.

Second, English speakers could not have learned a high ranking for MAXSTRESS-Noun on the basis of the non-blend phonology. Nouns and verbs do have different default stress patterns in English (Chomsky & Halle 1968; Ross 1973), but as both of these patterns involve defaults, this is not a matter of noun privilege. If anything, noun stress behavior is MORE predictable (LESS indicative of privileged preservation of underlying contrasts) than verb stress behavior. Kelly and Bock (1988:391), reporting stress data from Francis and Kučera (1982), show that English disyllables used only as nouns have an extremely strong preference for initial stress, with 94% of the 3002 nouns in Francis and Kučera's data showing this pattern. On the other hand, disyllables used only as verbs have a much less-strongly skewed preference: of 1021 verbs, final stress occurred only 69% of the time, with 31% of the verbs actually showing initial stress.

3.3. POSITIONAL PRIVILEGE FOR PROPER NOUNS. The third type of positional privilege that we investigate is that for proper nouns. Although phonological differences between proper and common nouns are even less thoroughly studied than those between nouns and verbs, there is typological evidence that proper nouns can have DIFFERENT phonological patterns from common nouns, as demonstrated by Sezer (1981) for Turkish and by Sugawara (2012) for Japanese. Crucially, there is even evidence from segmental deletion patterns in Canadian French (Walker 1984:96) and from a syncope process in Jordanian Arabic (Jaber 2011) that proper nouns can show STRONGER faithfulness effects than common nouns. These facts motivate proper noun as a category for which constraints enforcing positional privilege are potentially relevant.

As discussed in Sections 3.1 and 3.2, previous research provides evidence that neither heads nor nouns show effects of phonological privilege in the non-blend phonology of English. However, there has been much less discussion comparing the phonology of proper and common nouns in English. It is therefore necessary to make the case that effects of proper-noun privilege are emergent in English blends; that is, that English non-blend phonology does not immunize the class of proper nouns against contrast-neutralizing processes that affect common nouns.

Evidence for this claim comes from pairs of proper and common nouns which are related by zero conversion, such as the proper noun *Heather* (derived from the common noun *heather*) or the common noun *rugby* (derived from the proper noun *Rugby*). Proper-noun privilege could in principle lead to phonological differences with pairs like these. For example, in Jordanian Arabic (Jaber 2011), underlying short high vowels are banned from non-final unstressed open syllables in verbs, adjectives, and common nouns (with potential violations repaired by obligatory deletion), but surface faithfully in proper nouns. The result is that proper-noun/common-noun pairs may differ in phonology, as shown in 1.

<INSERT EXAMPLE 1 HERE>

To test whether ordinary (non-blend) English phonology similarly privileges proper nouns, we sought to replicate Jaber's study for English using lexical databases. First, the CELEX lexical database of British English (Baayen et al. 1995) was searched for all pairs of orthographic one-word noun lemmas (part-of-speech code 1 in Field 4 of the ESL.CD database) which differed only in capitalization of the initial letter, and whose non-initial letters were all lower-case. There were 219 such pairs. For each pair, all pronunciations (Field 6 of EPL.CD) of the capitalized and lower-case members of the pair were collected. In 211 cases (96%), the capitalized and lower-case orthographies had exactly the same pronunciations. In the remaining 8 cases, the set of pronunciations for the capitalized orthography differed from the set of pronunciations for the lower-case orthography: *Bar/bar* [bɑː]/[bɑːɹ], *Job/job* [ʤəʊb]/[ʤɒb], *Comforter/comforter* [ˈkʌ.fə.təɹ]/[ˈkʌm.fə.təɹ], *Aborigine/aborigine* [ˌæ.bə.ˈɹɪ.ʤɪ.ni]/[ˌæ.bə.ˈɹɪ.ʤə.ni], *Poll/poll* [pɒl]/[pəʊl], *Bass/bass* [bæs]/[beɪs], *Polish/polish* [ˈpəʊ.lɪʃ]/[ˈpɑ.lɪʃ], and *Benedictine/benedictine* [ˌbɛ.nɪ.ˈdɪk.tɪn]/[ˌbɛ.nɪ.ˈdɪk.tin]. One of these pairs seems to come from a typographical error (*Comforter/comforter*, where one pronunciation is missing the [m]). In at least three others, the orthographic similarity is coincidental (*Job/job, Bass/bass,* and *Polish/polish*). In none of the 4 remaining pairs could the proper/common difference be characterized as resistance to segmental deletion or stress shift by the proper noun.

A larger sample, with U.S. English (the variety spoken by our participants) but with less-reliable pronunciation data, was provided by combining the orthographies from *Webster's Second International Dictionary* (1934) in the Unix /usr/share/dict/web2 file with pronunciations from the CMU Pronouncing Dictionary (Weide 1998). Orthographic pairs differing in initial capitalization were found in the Webster's database. The orthographies were converted to all upper-case, so that each pair yielded one all-upper-case orthography. The CMU database, which uses all-upper-case orthographies, was searched for all pronunciations associated with each pair's orthography, and all pairs that were associated with more than one pronunciation were identified. Of the 1515 pairs, 78 had more than one pronunciation. These 78 were sifted to find etymologically related proper-common pairs, using the current on-line edition of the *Oxford English Dictionary (OED).* Pairs were excluded for the following reasons: 8 involved an abbreviation (e.g. *AVE* for *avenue*); the *OED* did not confirm the existence of the common noun in 10 cases (e.g., *HURON*); and in 27 cases there was no etymological connection between the proper and common noun (e.g. *NICE*). In the remaining 33 cases, a related proper and common noun with that spelling could be confirmed, and that spelling was associated with at least two pronunciations in the CMU database. In 24 of these cases, the difference was only in the pronunciation of an individual sound, for example, *COLORADO* [ˌkɑ.lə.ˈɹɑ.doʊ]/[ˌkɑ.lə.ˈɹæ.doʊ], *CAYENNE* [ˌkeɪ.ˈɛn]/[ˌkaɪ.ˈɛn]. The remaining 9 cases showed differences involving segment count (*CONCORD, ORIENTAL*), syllable count (*FEDERAL, NAPOLEON*), location of main word stress (*ANGELICA, GUARANI, NATAL, ROMANCE*), or both length and stress (*BARNARD*). The CMU database did not indicate whether the proper noun had one pronunciation and the common noun had the other, or whether both nouns had both pronunciations, but it is clear that the number of proper-common pairs related by segmental deletion or stress shift is very small.

In short, both database searches found that underlyingly identical proper and common nouns are treated alike by the phonological grammar of English, rather than the proper nouns being immune from processes that affect common nouns (or vice versa). Apparently, any well-formed common noun would be well-formed as a proper noun, and vice versa, without any need for phonological adaptation.

We can ask further: Does English exhibit more subtle effects of the proper/common distinction, which, while not strong enough to cause alternation, could lead a learner to infer a faithfulness difference? We know of only a few, and it is equivocal which they would support, proper-noun privilege or common-noun privilege. One is hypocoristic formation. We do not know of quantitative data on whether this suite of faithfulness-violating processes is more productive for proper or common nouns, but it is clear that many personal names undergo idiosyncratic changes from which common nouns are exempt, such as *Margaret* > *Peggy* (Bauer 2006:499). Another is inventory and phonotactics. In our databases (CELEX and CMU), there are no common nouns beginning with [ʒ] or [vl], only proper nouns (e.g. *Zhirinovsky*, *Vladimir*), which, for an Optimality-Theoretic learner, would indicate greater faithfulness to proper nouns. On the other hand, our databases give no proper nouns beginning with [θw] or [zl], only common nouns (e.g. *thwart, zloty*), which would indicate the reverse.

Is there evidence that English learners are especially tolerant of marked structures in proper nouns compared to common ones? The only relevant quantitative study we know of is that of Martin (2007, Ch. 3) on liquid co-occurrence restrictions. This study compared the actual frequency of /l ... l/ and /r ... r/ sequences to the expected frequency under the hypothesis of no association. In the general vocabularies of Old English, Middle English, and Modern English, about 25% of two-liquid words have the same liquid twice, compared to an expected proportion of about 50%, indicating that English (like other languages Martin considers) has a durable but 'soft' bias against identical-liquid sequences. Among 20th-century U.S. baby names, the expected frequency of /l ... l/ and /r ... r/ among two-liquid names in the 1000 most-used names has been about 50% in every decade, but the actual frequency has been below 20% since the 1930s, and was never more than about 25% (that is, names like *Leila* and *Gerard* are significantly underrepresented compared to names like *Laura* and *Roland*). Among brand names for drugs, the expected frequency is again about 50%, but the actual frequency is below 10% (names like *Dalalone* are significantly underrepresented compared to names like *Seleron* and *Oralet*; no examples were found for /r ... r/). In a database of fantasy role-playing game characters, Martin found that the expected rate was about 45%, but the actual rate is again below 20% (names like *Adraeran* and *Lylas* are significantly underrepresented compared to names like *Balor* and *Cynoril*). In a database of 'unusual baby names', the expected rate is about 50%, but the actual rate is close to zero (no examples of /l ... l/ or /r ... r/ were found, but there were several names like *Clarendy* and *Raleda*). Thus, for this particular marked structure, English names are if anything less tolerant of marked structures than English is in general. If faithfulness can be learned from probabilistic skews in the lexicon, this one would motivate common-noun faithfulness.

To sum up: Although the phonology of some languages accords special privilege to proper nouns vis-à-vis common nouns, the non-blend phonology of English does not. It treats underlyingly identical proper and common nouns alike with respect to phonological alternations, and does not seem to be more tolerant of phonological markedness in proper nouns than elsewhere (in some ways, it is less tolerant). Greater privilege for proper nouns than for underlyingly identical common nouns in English blend formation would therefore be a consequence, not of generalizing to blending a pattern found in ordinary phonology, but rather of a universal predisposition expressing itself in an area where the ordinary phonology does not override it—in Optimality-Theoretic terms, an emergent effect.

4. EXPERIMENTS. All of our experiments have a similar structure, based on the structure of Experiment 2 in Shaw (2013, Shaw et al. 2014). The experiments test whether English speakers, in forming blends, are more faithful to material which originates in a source word that is more prominent morphologically. Three different prominent positions were tested: semantic HEADS versus NONHEADS; NOUNS versus VERBS; and PROPER NOUNS versus COMMON NOUNS. These were fully crossed with two different kinds of phonological information, SEGMENTS and MAIN STRESS.

4.1. RATIONALE FOR SEGMENTAL EXPERIMENTS. The segmental experiments tested whether English speakers, in forming blends, are more faithful to segments which originate in a morphologically-prominent source word (a head rather than a nonhead, a noun rather than a verb, a proper noun rather than a common noun). The experiments exploit what Shaw (2013) calls ‘ambi-blendable’ source-word pairs. The idea is illustrated in 2 for the case of head faithfulness.

<INSERT EXAMPLE 2 HERE>

Phonologically, the two source words were chosen so that they could be blended in two different ways depending on which switch point was chosen. The source word pairs were affix-free nouns that shared two consonants surrounding a different stressed vowel; thus, the two candidate blend outputs differed only in their stressed vowel. Because the stressed syllable was non-initial in Word 1 and non-final in Word 2, the blend candidates differed from both of the source words. The earlier switch point preserved less of Word 1 and more of Word 2 than did the later one.

Morphosyntactically, Words 1 and 2 were chosen to create a structural ambiguity in the meaning of the blend such that only one of the two possible parses invoked the relevant Positional Faithfulness constraint. The experimental task was to match the two blend candidates with two definitions that embodied the two possible morphosyntactic parses (that is, participants were asked to match blends to definitions, rather than to classify blends or definitions using the terms ‘coordinating’ and ‘right-headed’). The *piranha-rhino* head-faithfulness example is illustrated in

3. The first definition is a semantically coordinating (two-headed) definition, because the hybrid is equally a piranha and a rhino. The second definition has a right-headed subordinating structure, because it defines a kind of rhino, not a kind of piranha. In matching the definitions to the blends, a participant is in effect assigning morphosyntactic structures to the two blend inputs.

<INSERT EXAMPLE 3 HERE>

Our linking hypothesis is that participants match blends to definitions so as to optimize constraint violations for both blend-definition pairs taken together. The tableau in 4 illustrates the application of this hypothesis to the *piranha-rhino* example. There are only two ways to match the two blends to the two definitions. One way, which we call Candidate (a), is to match the right-headed definition with the blend *pirhino*, and the coordinating definition with the blend *piranho*; the other, Candidate (b), does the reverse. The candidates differ in their violations of MAX(Head), a positional version of the usual MAX (McCarthy & Prince 1995), which penalizes segment deletion. By choosing Candidate (a), the participant endorses a lexicon from which the input /piranha + rhino (head)/ is produced with no MAX(Head) violations, and the input /piranha (head) + rhino (head)/ is produced with three. To choose Candidate (b) is to endorse a lexicon from which /piranha + rhino (head)/ is produced with two MAX(Head) violations, while /piranha (head) + rhino (head)/ is produced with three. Thus, for both inputs, Candidate (a)'s MAX(Head) violations are a proper subset of Candidate (b)'s. Since Candidate (a) and Candidate (b) score alike on non-positional MAX (as well as on other constraints, not shown, which do not involve headedness, such as markedness constraints), Candidate (a) harmonically bounds Candidate (b), and is therefore predicted to be preferred by the participant. In this optimization, alternative inputs compete to account for fixed surface forms; hence, it is a variety of Lexicon Optimization (Prince & Smolensky 1993; Smolensky 1996) in which optimal inputs are chosen for two outputs simultaneously. The *piranha-rhino* example is representative in that the same harmonic-bounding relation obtains for other candidates generated according to the same blend-formation schema $AxByC + PxQyR \rightarrow AxByR/AxQyR$, where xQ and bY have the same length. Specifically, x and y are the two switch points, A and R represent the segment strings that begin Word 1 and end Word 2 respectively, and the choice of B or Q for the material between the switch points is the crucial difference between maximizing segmental material from Word 1 versus Word 2.

<INSERT EXAMPLE 4 HERE>

The italics and underlining show the correspondence relations between the output segments and the input. In these candidates, the segment constituting the switch point is simultaneously italicized and underlined to show that it is a faithful correspondent of input segments from both source words (a proposal attributed by Piñeros 1999 to Janda 1986).[2]

If HEAD is replaced by a different prominent position, such as NOUN or PROPER NOUN, the theory of Positional Faithfulness predicts the existence of an analogous Positional Faithfulness constraint (MAX(Noun) or MAX(ProperNoun)), which allows the construction of an analogous segmental experiment with an analogous predicted outcome.

4.2. RATIONALE FOR STRESS EXPERIMENTS. The rationale for these experiments is the same as that just described, with faithfulness to stress in place of faithfulness to segments. In each source-word pair, the (unique) switch point follows the main-stressed vowel of Word 1 but precedes the main-stressed vowel of Word 2. This forces a choice as to whether the main stress of the blend should precede or follow the switch point. In this experiment, Word 1 has initial stress and Word 2 has final stress and the participant is offered a trochaic and an iambic blend. An example is shown in 5.

<INSERT EXAMPLE 5 HERE>

The experimental task was to match the trochaic and iambic blends to definitions which imply different morphosyntactic structures in the input, and which therefore create a difference in positional faithfulness (as in the segmental experiment, participants were not explicitly asked about morphosyntactic structures). An example where the morphosyntactic difference is a coordinating versus a right-headed structure is shown in 6.

<INSERT EXAMPLE 6 HERE>

Under the linking hypothesis (that definitions are matched so as to optimize constraint violations), the right-headed definition is predicted to be matched preferentially with the iambic blend, which matches the stress of Word 2 and mismatches that of Word 1, as shown in Tableau 7.

<INSERT EXAMPLE 7 HERE>

This tableau is parallel to Tableau 4. In Candidate (a), the definition that makes the iambic Word 2 the head is matched with the iambic blend, whereas in Candidate (b), that definition is matched with the trochaic blend, incurring a MAXSTRESS(Head) violation. MAXSTRESS(Head) is a positional version of MAXSTRESS, which requires the output correspondent of a stress-bearing input segment to bear stress as well (McCarthy 1995, Kager 2000, Alderete 2001, Alber & Plag 2001). Other constraints that are indifferent to stress and headedness do not distinguish between Candidate (a) and Candidate (b), so Candidate (a) harmonically bounds Candidate (b) and is therefore predicted to be the preferred choice. Replacing HEAD with another strong position leads to analogous predictions in analogous experiments. Experiments reported in this paper are summarized in 8; for explanations of the relevant ambiguities exploited by the stimuli in each experiment, see the individual experiment descriptions in Section 5 below.

<INSERT EXAMPLE 8 HERE>

The definition-matching task (Shaw 2013) is a two-alternative forced-choice task; on each trial, two different blend outputs are presented, and the participant is asked to decide whether (e.g.) the first is coordinating and the second is right-headed, or vice versa. The main advantage over a single-interval task is that the two-alternative choice task minimizes response bias (Macmillan & Creelman 2004:179). For instance, if each trial consisted of presenting a single definition and asking for a choice between two possible blend outputs, participants might always prefer the output with initial stress, obscuring subtle differences in the strength of that preference as a function of the headedness of the definition.

4.3. DESIGN AND METHODS. For each experiment, nine source-word pairs with associated candidate blends and definitions were constructed (complete lists are given in Section 5). In all of the experiments reported in this paper, the definitions in each pair were exactly matched for order of the two source words, and were approximately matched for length and for linear position of the source words. The segmental experiments used written stimuli only, with source words presented in American English orthography and blends presented in plausible orthography based on that of the source words. For the stress experiments, each of the two blend candidates (e.g. *flóundine* and *floundíne*) was pronounced by a phonetically sophisticated female native speaker of American English (JLS) and digitally recorded using an ATR 2500-USB Side Address USB Microphone (Audio Technica Corp.) in a double-walled soundproof chamber (Ray Proof Corp.) at a 44.1-kHz sampling rate in WAV format. Praat (Boersma & Weenink 2013) was then used to edit the stimuli. Stimuli were trimmed so that they began at the first zero crossing preceding the first visible evidence of a signal on the waveform and spectrogram, and so that they ended at the zero crossing following the disappearance of a distinct second formant. Each token was then scaled to a peak amplitude of ±0.975 of the available dynamic range, and 0.5 s of silence was added to the end. The WAV-format files were converted to the lossily-compressed MP3 and OGG formats using the software *lame* (LAME Project, lame.sourceforge.net), *afconvert* (Apple Computer Corp.), and *Ogg Drop X* (vorbis.com).

The survey was administered as a web-based experiment using a modified version of the Experigen software (Becker 2013). It consisted of four different sections including instructions, an example, the main experiment, and a post-survey questionnaire. The written instructions briefly explained what a blend is, and said that the participants will be asked to match blends with definitions (see Appendices A, B). The response interface was then demonstrated using a practice example. For participants in segmental experiments, the practice example was like a trial of the main experiment, using an extra (tenth) blend pair and with explanatory text on the page. For those in the stress experiments, the practice example familiarized them with the use of stress marks by asking them to match *óbject* and *objéct* with definitions of the noun and the verb. The main experiment then followed. On each trial, participants were shown two blend candidates above two definitions (see Figure 1). In the stress experiments, audio controls below the candidates could be clicked on to play audio of each candidate.[3] Participants indicated their choice by dragging either of the blends into the blank in one of the definitions (this automatically put the other blend into the other blank). Once made, this choice could be revised until the participant was satisfied with the matching. Below the definitions was a five-point radio-button scale, with which participants rated the difficulty of the trial from ‘very easy’ to ‘very hard’.[4]

After both the blend-matching question and the difficulty-scale question had been answered, the participant was able to click through to the next trial. For each source-word pair, there were two ways to order the two blend candidates and two ways to order the two definitions. Four versions of the experiment were used to counterbalance both orders across participants. The sequence of the trials was randomized individually for each participant. Lastly, in the debriefing questionnaire (see Appendix C), participants were asked what, if any, strategy they employed and whether any of the blend pairs were particularly difficult. They were also asked for demographic information such as their handedness, gender, level of education, and native language.

<INSERT FIGURE 1 HERE>

4.4. PARTICIPANTS AND OTHER DETAILS. Participants were recruited using Amazon Mechanical Turk, an online labor exchange (Sprouse 2011). They were offered US $1 for completing a '7- to 15-minute survey about how you blend words (should blue + green be "bleen" or "breen")?' Across all of the experiments reported in this paper, the average time to complete the experiment, including the post-experiment questionnaire, was 10 minutes 29 seconds.

Mechanical Turk has proven reliable in past linguistic and psychological studies (Sprouse 2011, Crump et al. 2013). Recruitment criteria were set so that all participants were in the United States, had done at least 100 Mechanical Turk assignments (for any employer, not necessarily our research group) which were afterwards approved for payment by the employer, and had at least a 95% approval rating on previous Mechanical Turk tasks.

A participant's data was excluded from further analysis for any of several reasons: failure to complete all nine test trials, leaving any demographic question unanswered, reporting a language other than English as first language, or, in the stress experiments, giving an incorrect response to the practice question (matching *óbject* and *objéct* to the wrong definitions). The exclusions in each experiment are shown in Table 1.

<INSERT TABLE 1 HERE>

Table 2 shows the total number of participants run in each experiment, the number of valid participants remaining after the exclusions, and basic demographic characteristics of the valid participants. No one participated in more than one experiment.

<INSERT TABLE 2 HERE>

5. RESULTS. Following Shaw (2013), we analyzed the data in two ways. For the 'By-Participant' analysis, the unit of observation was the participant. Since there were nine trials, each participant gave either mostly positionally-faithful responses, or mostly positionally-unfaithful ones. A participant who gave mostly positionally-faithful responses was coded as 1, else as 0. The observed proportion of positionally-faithful responders was compared to the chance level of 0.5 using a one-sided exact binomial test (*binom.test* in the *stats* package of the statistical software *R*; R Core Team, 2014). If the observed proportion significantly exceeded chance, that meant that participants tended to be positionally-faithful responders. The by-participant analyses for all experiments are shown together in Table 3; they will be discussed separately below in the section devoted to each experiment.

<INSERT TABLE 3 HERE>

For the 'By-Response' analysis, the unit of observation was the individual response. Each response was coded as positionally faithful (1) or not (0). A mixed logistic-regression model was fit using the *lmer* method in the *lme4* package of the statistical software R (Bates, Maechler, & Bolker, 2011). The model had a single fixed term, the intercept, with random intercepts for each participant and each of the nine items. The intercept was compared to its chance level of 0. If the intercept significantly exceeded chance, that meant that responses tended significantly to favor the positionally-faithful association of blends to definitions. The fixed-effects portion of the fitted model for each analysis is shown in Table 4; these, too, will be discussed together with the individual experiments.

<INSERT TABLE 4 HERE>

5.1. EXPERIMENTS 1 AND 2: PHONOLOGICAL PRIVILEGE FOR HEADS. Our first experiments were intended to replicate Experiments 1 and 2 of Shaw (2013; Shaw et al. 2014), which found emergent effects of phonological privilege for heads (versus nonheads), and to check that the same results could be achieved using Mechanical Turk participants and the drag-and-drop interface. Experiment 1 investigated head faithfulness to segmental content. There were nine items for this experiment consisting of the eight original items from Shaw's (2013) Experiment 2 and one additional item of our creation, *piranha* + *rhino*, so that there would be an odd number of items, insuring that each participant would be majority-head-faithful or majority-head-unfaithful. Each blend pair had two definitions, one of which was coordinating and the other of which was right-headed. The definitions were optimized so that their structure was as similar to each other as possible. If one definition contained a source word then the other definition would contain that word as well. The length of the definitions was also made as consistent as possible within each pair. The blends and definitions are given in 9.

<INSERT EXAMPLE 9 HERE>

The results in Table 3, repeated in Table 5a for convenience, show that the number of participants who choose a majority of head-faithful responses was significantly greater than chance. The results in Table 4, repeated in Table 5b, show that the definition which made Word 1 a modifier and Word 2 a head was more likely to be matched with the blend that preserved more of Word 2, as predicted by head faithfulness.

<INSERT TABLE 5 HERE>

Experiment 2 focused on head faithfulness to lexical stress. There were also nine items for this experiment consisting of the eight items from Shaw's (2013) Experiment 1 as well as one item that we created, *lizard* + *gazelle*. The items are shown in 10.

<INSERT EXAMPLE 10 HERE>

Participants in Experiment 2 were significantly more likely than chance to give a majority of head-faithful responses, as shown in Table 6a (from Table 3). Individual responses were also significantly more likely than chance to be head-faithful, as shown in Table 6b (from Table 4).

<INSERT TABLE 6 HERE>

The results of Experiments 1 and 2 replicate those of Shaw (2013, Shaw et al. 2014), confirming that we can find the same pattern of results despite minor differences in experimental procedure (the drag-and-drop interface, and the blanks following rather than preceding the definition) and larger differences in the participant population (anonymous Amazon Mechanical Turk workers rather than personal acquaintances of the experimenter). Having replicated Shaw's head-faith effect, we next ask whether an analogous effect can be found for a different prominent position, nouns.

5.2. EXPERIMENTS 3A,B AND 4A,B: PHONOLOGICAL PRIVILEGE FOR NOUNS. Experiments 3 and 4 were analogous to Experiments 1 and 2, except that the prominent position was nouns (vs. verbs) rather than heads (vs. nonheads). (The difference between the *a* and *b* versions had to do with the lexical category of Word 2, as will be explained shortly.) In Experiments 1 and 2, the ambiguity was structural rather than lexical: The same two source words could be parsed as either a subordinating or a coordinating structure. In Experiments 3 and 4, the reverse was true: The structure was always subordinating, but Word 1 could be interpreted as either a noun or a verb.

Phonologically, the source words were chosen to be blendable in two ways: In Experiment 3, each source-word pair had two possible switch points, for example, *brood* + *ridicule* could be blended as *broodicule*, switching at the [d] and preserving more of *brood*, or as *bridicule*, switching at the [r] and preserving more of *ridicule.* In Experiment 4, the switch point followed the stress of Word 1 but preceded the stress of Word 2, forcing a choice as to which stress to preserve; for example, *wátch* + *chóose* could be blended as *wátchoose*, preserving only Word 1's stress, or as *watchóose*, preserving only Word 2's stress.

Morphosyntactically, Word 1 was ambiguous between a noun and a homophonous verb. In order to maximize the distinction between the noun and verb definitions, we chose homophones whose nominal and verbal meanings were as unrelated to each other as possible. For example, *watch* was acceptable, because the meanings of ‘look at’ and ‘chronometer’ are distinct, but *bike* was not, because the verb *bike* and noun *bike* are transparently related. This criterion sharply restricted the set of usable Word 1s, such that we had to use shorter Word 1s than in Experiments 1 and 2. In particular, Word 1 in the stress experiments (Experiments 4a and 4b) was a monosyllable, rather than a trochee as in Experiment 2.

In Experiments 3a and 4a, Word 2 was a verb, and the lexical ambiguity in Word 1 meant that the blend was ambiguous between a subordinating verb-verb structure and a subordinating noun-verb structure (e.g. *brood* + *ridicule* makes the verbs *broodicule* and *bridicule*). In Experiments 3b and 4b, Word 2 was a noun, and the blend was ambiguous between a subordinating verb-noun structure and a subordinating noun-noun structure (e.g. *fling* + *language* makes the nouns *flinguage* and *flanguage*). Since the structure was in either case subordinating, the head-faithfulness effects found in Experiments 1 and 2 would not have biased the outcome; any bias towards preserving material in Word 2 would have affected both candidate responses equally.

For Experiments 3 and 4, right-headed nominal and verbal definitions were created for each source word pair. The definitions were written so that the unambiguous part, corresponding to Word 2, was always stated first, with the subordinate ambiguously verbal or nominal part, corresponding to Word 1, stated second. As in Experiments 1 and 2, the paired definitions were written so that their lengths were as similar as possible. If one definition explicitly used a source word then its counterpart did as well. The blends and definitions used in Experiments 3a and 3b are shown in 11 and 12. Those used in Experiments 4a and 4b are shown in 13 and 14.

<INSERT EXAMPLE 11 HERE>

<INSERT EXAMPLE 12 HERE>

<INSERT EXAMPLE 13 HERE>

<INSERT EXAMPLE 14 HERE>

Participants in all four experiments were more likely than chance to give mostly noun-faithful responses, as shown in Table 7a (repeated from Table 3). The tendency was significant at the conventional 0.05 level or above for both of the segmental experiments (3a and 3b) and for the stress experiment in which Word 2 was a noun 4b; it was also marginally significant ($p < 0.10$) for the stress experiment in which Word 2 was a verb 4a. However, when mixed logit models were fit to the individual responses, the intercepts were all numerically positive (i.e. in the predicted direction), but the difference was significant only for Experiment 4b, the stress experiment in which Word 2 was a noun. These results are consistent with the hypothesis that blend formation is influenced by Positional Faithfulness for nouns, but they do not support it strongly.

<INSERT TABLE 7 HERE>

In Experiments 1 and 2, the ambiguity was structural rather than lexical: The same two source words could be parsed as either a subordinating or a coordinating structure. In Experiments 3 and 4, the reverse was true: The structure was always subordinating, but Word 1 could be interpreted as either a noun or a verb. The strength of the noun-faithfulness effect could therefore depend on the degree of ambiguity of Word 1. Were the Word 1s in Experiments 3 and 4 simply not ambiguous enough in their semantic meaning or syntactic category to show a noun-faithfulness effect? If so, perhaps the most-ambiguous items did exhibit an effect, which was diluted by the less-ambiguous ones. To test this possibility, the Unambiguousness of each Word 1 was quantified as the absolute value of the difference between the natural log of its frequency as a verb and that of its frequency as a noun as given in the CELEX database (Baayen et al. 1995, file

ESL.CD). (Thus, if the noun and verb were equally frequent, the Unambiguousness was zero, whereas if they differed in frequency (in either direction), the Unambiguousness was greater.) Across all stimuli in the four experiments, Unambiguousness ranged from 0.02 to 4.43, with a mean of 0.97. For each of the four models, Unambiguousness was added as a predictor to the fixed effects, and random slopes were added to the random effects for Unambiguousness by participant and by item. Each augmented model was then compared to the corresponding original model by a likelihood-ratio test using R's *anova* method. In no case did the augmented model fit significantly better than the original; hence, the results do not support the dilution hypothesis.

5.3. EXPERIMENTS 5A,B AND 6A,B: PHONOLOGICAL PRIVILEGE FOR PROPER NOUNS. The third set of experiments investigated whether proper nouns are privileged relative to common nouns. As with Experiments 3a,b and 4a,b, the strategy was to make Word 1 lexically ambiguous, this time between a proper noun and a common noun, and to test whether the definition which made Word 1 a proper noun was preferentially paired with the blend that preserved more of Word 1. Experiments 5a,b focused on segmental faithfulness and used the same phonological criteria as Experiments 1 and 3a,b (e.g. *BOHEMIAN* + *HUMMUS* could yield either *BOHEMUS*, preserving more of *BOHEMIAN*, or *BOHUMMUS*, preserving more of *HUMMUS*), while Experiments 6a,b focused on stress faithfulness and used the same phonological criteria as Experiments 2 and 4a,b (e.g. *TÚRKEY* + *TYCÓON* could yield either *TÚRCOON,* preserving the stress of TURKEY, or *TURCÓON*, preserving the stress of *TYCOON*). Since the experiment hinges on the ambiguity of Word 1, it was important to make sure that each Word 1 really was ambiguous, that is, that the proper-noun reading really was known to the average Mechanical Turk worker. A preliminary list of ambiguous proper nouns was drawn up and then winnowed down by having them rated for familiarity (as proper nouns) on a scale of 1 to 7 by a separate sample of 21 Mechanical Turk workers. The results of this preliminary, informal survey were used by the experimenters to guide their choice of stimuli by giving a rough indication of the familiarity of the proper nouns which the experimenters had been considering. The items actually used in the experiments are shown in 15 and 16. Systematic familiarity ratings were collected from the actual participants in the experiment, as described in detail below.

<INSERT EXAMPLE 15 HERE>

<INSERT EXAMPLE 16 HERE>

Unlike previous experiments, participants in Experiments 5a and 6a were asked to rate, not how difficult each trial was, but how well-known they felt the proper noun that made up each stimulus was. For example, participants were asked 'How well-known is Hamlet to people in the US?'. The participants gave their answer on a scale of 1 to 7 (as in Steffens et al. 2005), with 1 being labeled as 'Known by Almost No One' and 7 being labeled as 'Known by Almost Everyone'. The goal of this question was to elicit a rating for how familiar each subject was with the proper nouns used in the stimuli. This functioned as a way of insuring the participants knew that the proper nouns were proper and replaced the question regarding difficulty ('How hard was it to decide?') that the previous experiments asked. To check whether the familiarity-rating question itself was influencing responses on the blend-matching task, Experiments 5b and 6b used the original difficulty-rating question instead of the familiarity-rating question.

Another difference between Experiments 5 and 6 and the other experiments was the use of capitalization in the stimuli. Since capitalizing only the first letter in a blend could have suggested that it was a proper noun and since not capitalizing any of the letters could have suggested to the participants that it was a common noun, the stimuli were presented in all capital letters. The results were clear: In three of the four proper-vs.-common-noun experiments, individual participants were significantly more likely than chance to give mostly positionally-faithful responses, and the fourth missed significance by a single participant (see by-participant portion of the table in Table 8). In all four experiments, responses were significantly more likely than chance to be positionally faithful (see by-response portion of the table in Table 8). These results are consistent with the hypothesis that blend formation is affected by emergent Positional Faithfulness for proper over common nouns, in both segments and stress.

<INSERT TABLE 8 HERE>

6. GENERAL DISCUSSION. The results of our experiments show that what we have hypothesized to be morphologically strong positions (heads, nouns, and proper nouns) evoke emergent positional-privilege effects in English, in the sense that when matching definitions to novel blends, speakers are more likely to choose a matching in which the properties of the strong position are preserved. These effects are small, but consistent across all ten experiments, which makes it unlikely that we have observed them by chance. Moreover, effects of positional privilege for heads in blend formation have been observed in similar experiments in Japanese (Broad 2015) and Spanish (Crouse 2016). We now consider some consequences of these findings for linguistic theory and some directions for future work.

6.1. PHONETICS IN PHONOLOGY. Positional neutralization and positional privilege are at the heart of debate over the role of phonetics in phonology, that is, the question of why phonological grammars so often make sense in phonetic terms. In one view, phonological grammars are actively shaped by speakers' innate or acquired knowledge of phonetics, which provides an inductive bias that steers acquisition, change, and typology in particular directions (e.g. Stampe 1979; Archangeli & Pulleyblank 1994; Boersma 1998; Steriade 1999, 2001ab; Hayes 1999; Wilson 2006; Kiparsky 2008; Berent 2013). An alternative proposal is that phonological grammars are passively shaped by phonetically-biased distortions in the speaker-to-hearer channel which cause the learner to misperceive speakers' intended utterances (e.g. Ohala 1981, 1993; Hale & Reiss 2000; Blevins 2004; for recent reviews see Hansson 2008; Garrett & Johnson 2013). The channel-bias proposal has the advantage of theoretical parsimony, since it does not require phonetic facts which already exist in the real world to be duplicated in the mind of the speaker (Anderson 1981). The typological fact that, for example, stressed vowels tend to resist reduction that affects unstressed ones could be due to an inductive bias against grammars that reduce stressed vowels, but it could also be due simply to the easily observable phonetic fact that learners hear stressed vowels more clearly than unstressed ones, and are less likely to mishear them as unstressed (Kochetov 2002, 2003; Jonathan Barnes 2006). The same argument applies to other 'phonetically' strong positions: Inductive and channel bias can both account for the typological facts, but the hypothetical inductive bias recapitulates the known channel bias.

The parsimony advantage for the channel-bias hypothesis is not removed by showing that a positionally restricted process is productive in a language, because the issue is not whether learners can or cannot acquire a positionally restricted grammar; all sides agree that they can. If the ambient language reduces only unstressed vowels, the learner will acquire a grammar that encodes that fact. The real issue is whether the learner is equipped with inductive biases that make positional privilege in strong positions easier to learn than positional privilege in weak ones. Phonological learning experiments ('artificial-language' experiments) might offer a more direct test of whether one kind of grammar is easier to learn than another, but their interpretation is complicated by the fact that participants are perceiving the stimuli through a potentially distorting phonetic channel (for example, they could mishear the unstressed vowels in the lab the way they do in nature, and so have a harder time learning one of the grammars accurately).

Here is where emergent positional privilege in morphologically strong positions comes in. As discussed in Section 3 above, these positions are salient for non-phonetic reasons—which means that the alternative, channel-bias explanation for their phonological privilege is not so readily available. We have seen that there are languages in which heads, nouns, and proper nouns resist phonological processes that affect nonheads, verbs, and common nouns; hence, positional-faithfulness theory (Beckman 1999, Smith 2001) implies that the universal constraint set contains faithfulness constraints relativized to these strong positions but not to their complements (an inductive bias in favor of positionally-faithful grammars), and thus predicts that the effects of those constraints may emerge in languages where they are not evident in the ordinary phonology, such as English. We have furthermore argued that there is no phonological evidence (from e.g. alternations or phonotactics) for head, noun, and proper-noun privilege available to the learner of English. Crucially, the channel-bias hypothesis does not predict that head, noun, or proper-noun privilege effects will emerge in English, because the complements of these positions—that is, morphologically weak positions—are not subject to mishearing in the same way that phonetically weak positions are. The fact that positional-privilege effects WERE observed in the blend task supports the inductive-bias hypothesis for head, noun, and proper-noun faithfulness—or if necessary for an alternative formal implementation of positional privilege, as discussed in Section 2.1. And if there are inductive biases for privilege in these positions, it is no longer so unparsimonious to hypothesize inductive biases for privilege in other positions.

The present results are consonant with Becker, Nevins, & Levine's (2012) finding that English speakers, when learning an artificial analogue of German plural formation in which a prefix or suffix is accompanied by a change in the backness of the stressed root vowel, generalized the pattern from root-initial to root-final syllables more readily than the reverse. Becker and colleagues interpret these results as emergent initial-syllable faithfulness, a typologically attested pattern (e.g. in Shona) which is absent from (and in some ways contradicted by) ordinary English phonology.

6.2. WHAT MAKES A POSITION 'STRONG'? We take the results of our experiments to support the idea that constraints enforcing positional privilege in nouns, heads, and proper nouns are universally available, that is, they are in the constraint set of adult speakers of every language. We have argued that such constraints could not have been learned from the English lexicon, so their emergence in our experiments suggests that they exist prior to or independent of phonological learning. However, we remain agnostic about whether these constraints are part of an innate constraint set or whether they are universally available for another reason. For example, these constraints might be projected from some component of cognition that deals with semantic 'salience', in a manner analogous to phonetic inductive grounding as proposed by Hayes (1999) (see also Smith 2005 for discussion of constraint induction involving psycholinguistic salience). On this latter view, heads, nouns, and proper nouns are predicted to be more salient (by psycholinguistic criteria such as those described in Beckman 1999, Ch. 2, or by some set of criteria diagnosing semantic salience) than nonheads, non-nouns, and common nouns, respectively. Likewise, other salient positions are predicted to have corresponding positional-privilege constraints. A position that passes any one of the three tests (asymmetric privilege typologically, emergent privilege, and semantic or psycholinguistic salience) should pass the other two as well.

If positional constraints are derived by freely relativizing existing constraints to prominent positions (Smith 2004), a further prediction is made. Prominent positions do not only resist positional neutralization, they also undergo POSITIONAL AUGMENTATION (Smith 2005), a markedness-driven process that enforces high perceptual salience. For example, Tuyuca enhances the perceptual salience of roots by requiring them to bear (non-contrastive) stress (Janet Barnes 1996). Hence, we expect any prominent position, including heads, nouns, and proper nouns, to spawn corresponding augmentation constraints, which, when ranked above faithfulness, would cause them to undergo positional augmentation. Sugawara's (2012) finding that Japanese personal names (proper nouns) preferentially bear a pitch accent may be evidence in support of this prediction. In the long run, we hope that this research program will lead to a general unifying theory of what makes particular positions more salient than their complements, and of what common property unites morphological positions like heads, nouns, and proper nouns with initial syllables, stressed syllables, roots, and other strong positions—that is, positions whose salience derives from both phonetic and non-phonetic factors.

Finally, our results have broader implications for the role of lexical categories in positional-privilege effects. The typological survey in Smith (2011) indicates that there is a hierarchy of phonological privilege among the major lexical categories, N > A > V. Our experiment results, together with the phonological analyses of Walker (1984) and Jaber (2011), show that the category N can be further subdivided into proper nouns and common nouns: PrN > cN > A > V. This finding then raises the question of whether verbs or adjectives likewise show differences in phonological privilege among their subcategories. More broadly still, what is the ultimate origin of this hierarchy of phonological privilege? The scale PrN > cN > A > V appears to be a continuum from prototypical rigid designators (PrN) to prototypical predicates (V), and furthermore strongly resembles continuum models of lexical categories that have been proposed for morphosyntactic or semantic reasons (e.g. Ross 1972; Langacker 1987; Croft 1990). This resemblance is striking, but further explorations of the structure and origin of the hierarchy of PHONOLOGICAL privilege among lexical categories must remain a question for future work.

Appendix A. Instructions for segmental experiments (Experiments 1, 3ab, and 5ab).

Blends are words made by combining two other words, like **brunch** (*breakfast* + *lunch*) or **motel** (*motor* + *hotel*). In this survey, you'll see some new blends and match them to definitions. There are no wrong answers, and you can stop at any time.

(Next page:)

On each page, you'll see a pair of words that can be combined into two different blend words. These blends have different definitions; your task is to **match each blend with the definition it fits best with**.

The definitions below describe two kinds of **cayenne unicorn**. One of them is a **cayenicorn** and the other one is a **cayunicorn.** Click on one word, drag it to the box next to its definition, and drop it in the box.

When you drag one word to a definition box, the other will automatically appear in the opposite box. You can then switch the words as many times as you like by dragging one word into the opposite box.

[Followed on the same page by a display like that shown in Figure 1.]

Appendix B. Instructions for stress experiments (Experiments 2, 4ab, and 6ab).

Blends are words made by combining two other words, like **brunch** (*breakfast* + *lunch*) or **motel** (*motor* + *hotel*). In this survey, you'll see some new blends and match them to definitions. There are no wrong answers, and you can stop at any time.

(Next page:)

On each page, you'll see a pair of words that can be combined into two different blend words that are **spelled the same but pronounced differently**. These blends have different definitions; your task is to **match each blend with the definition it fits best with**.

We use underlines and áccent marks to show which syllable is stressed. In Énglish, stress úsually doesn’t make a dífference in méaning, but sómetimes it does; when the únderdog wins, it’s an úpset, but you might not be upsét about it.

The stress marking is important, so on the next page we'll give an example with a familiar word (not a blend). There will be **audio recordings** to show what the stress marks mean.

(Next page:)

The definitions below describe two meanings of the word **object**. Click on one word, drag it to the box next to its definition, and drop it in the box.

When you drag one word to a definition box, the other will automatically appear in the opposite box. You can then switch the words as many times as you like by dragging one word into the opposite box.

[Followed on the same page by a display like that in Figure 1, but with audio controls as explained in the text describing Figure 1. The definitions are: “to express disapproval is to”, “a thing is an”.]

Appendix 3. Post-experiment questionnaire.

Thank you for your participation! Please answer the following questions.

Did you have a strategy you used to help answer the questions? If so, what was it? [Free-response text box.]

Were there any pairs that were particularly hard, or that don't work for you? [Free-response text box.]

When were you born? [Drop-down menu of years from 1900 to 2010.]

What is your sex? [Drop-down menu of none, Male, Female.]

What is your dominant hand? [Drop-down menu of none, Right, Left, Neither/Both.]

What is the highest level of education you have completed? [Drop-down menu of none, Some high school, High school/GED, Some college, Associate's, Bachelor's, Master's, Other Advanced Degree.]

What is(/are) your native language(s)? [Free-response text box.]

Do you speak a particular **regional** dialect of English (Southern, British, etc.)? If so, what? [Free-response text box.]

What other languages do you speak, and how well do you speak them? [Free-response text box.]

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Notes

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[1] More recent work by Plag (2006; Plag et al. 2008) argues based on evidence from corpus data that the Compound Stress Rule actually fails to hold for as many as half of noun-noun compounds in English, and that this rule cannot be saved by appealing to additional factors such as the semantic relationship between the head and nonhead, argument structure, etc. Bauer (2004) makes similar claims about adjective-noun compounds. Still, there is no evidence that heads are privileged with respect to stress in English compound stress assignment.

[2] Our model assumed that participant decisions were influenced only by the most-harmonic candidate consistent with each assignment of definitions to blends. Homophonous candidates which have less overlap than Candidates (a) and (b) are harmonically bounded by Candidates (a) and (b), and so are omitted from the tableau. Depending on assumptions about contiguity constraints (McCarthy & Prince 1995), it could be that Candidates (a) and (b) are less harmonic than corresponding candidates (a’) and (b’) in which non-contiguous identical segments are shared (e.g. piranha + rhino → piranho), an assumption made by, for example, Piñeros (2004). However, substituting Candidates (a’) and (b’) for Candidates (a) and (b) would not change the subset relationship between the candidates’ violation marks, and hence would not change the predictions of the Positional-Faithfulness hypothesis: Participants are predicted to prefer the head-faithful option.

[3] Across all of the experiments that involved listening to audio (the stress experiments), the median number of times that each blend candidate was listened to was 1. The mean number of times that each blend candidate was listened to was 1.35.

[4] Decision-difficulty ratings were collected in Experiments 1, 2, 3, 4, 5b, and 6b for two reasons: (a) in order to replicate exactly the procedure used in Shaw (2013), and (b) in order to test the hypothesis that positionally-faithful responses would be more likely on trials that evoked stronger intuitions (as one would expect if responses were based on intuitions about positional faithfulness). In analyzing each experiment, the ratings were z-transformed with respect to their grand mean and standard deviation for all participants in that experiment. The transformed rating was added as a fixed effect in the intercept-only model, and random slopes for rating by item and by participant were added to the random effects. Rated difficulty proved significant or marginally so only in Experiments 3 and 6b, where in fact higher ratings were associated with a LOWER rate of positionally-faithful responses. It is difficult to conclude anything from such weak and contradictory evidence, but the hypothesis that strong intuitions are associated with positionally-faithful responses was at any rate NOT supported. In Experiments 5a and 6a, rated familiarity was analyzed the same way (see Section 5.3); its effect was not significantly different from zero in either experiment. The effects of the difficulty and familiarity ratings are not discussed further in this paper.

Special Matter

(1) Common/proper noun pairs in Jordanian Arabic, showing resistance of proper nouns to open-syllable high-vowel deletion (Jaber 2011).

Proper noun	Common noun	Gloss
si.'raadʒ	'sraadʒ	‘oil lamp’
ʃu.'huud	'ʃhuud	‘eyewitness’
su.'dʒhuud	'sdʒuud	‘prostration’
si.'haam	'shaam	‘arrows’
xu.'luud	'xluud	‘eternity’
wu.'ruud	'wruud	‘flowers’
zu.'huur	'zhuur	‘roses’
ʃa.'faaʔ	'ʃa.fa	‘clarity’
du.'çaaʔ	'du.ça	‘supplication’
ha.'naaʔ	'ha.na	‘happiness’

(2) Ambi-blendable source-word pair, showing two possible switch points.

piranha	p	ɪ	ɹ	ɑ	n	ə
			↓		↓	
rhino			ɹ	aɪ	n	oʊ

(3) Experimental task: Which definition defines a *piranho*, and which defines a *pirhino*?

Condition	Definition	Morphosyntax implied by definition
Coordinating	A hybrid of a rhino and a piranha.	piranha (head) + rhino (head)
Right-headed	A rhino that is fierce like a piranha.	piranha + rhino (head)

(4) Head faithfulness prefers Candidate (a) because it matches the right-headed definition—the one that makes Word 2 a head—with the blend that preserves more of Word 2. Italics and underlining show correspondence relations.

			MAX(Head)	MAX
⇒ a.	*piranha* + rhino (hd)	→ *pir*hino		*a n ə*
	piranha (hd) + rhino (hd)	→ *piran*ho	*ə* ɹ aɪ	*ə* ɹ aɪ
b.	*piranha* (hd) + rhino (hd)	→ *pir*hino	*a n ə*	*a n ə*
	piranha + rhino (hd)	→ *piran*ho	ɹ aɪ	*ə* ɹ aɪ

(5) Source word pair, showing two possible stress patterns for the output.

		Stress pattern of blend	
Word 1: initial stress	Word 2: final stress	trochaic	iambic
flóunder	sardíne	flóundine	floundíne

(6) Experimental task: Which definition defines a *flóundine*, and which defines a *floundíne*?

Condition	Definition	Morphosyntax implied by definition
Coordinating	A cross between a sardine and a flounder.	flounder (head) + sardine (head)
Right-headed	A type of sardine eaten by flounder.	flounder + sardine (head)

(7) Head faithfulness prefers Candidate (a) because it matches the right-headed definition—the one that makes Word 2 a head—with the blend that preserves the stress of Word 2. Italics and underlining show correspondence relations.

	MAXSTRESS(Head)	MAXSTRESS
⇒a. *flóunder* + sardíne (hd) → *floundíne*		*
flóunder (hd) + sardíne (hd) → *flóund*ine	*	*
b. *flóunder* (hd) + sardíne (hd) → *flound*íne	*	*
flóunder + sardíne (hd) → *flóund*ine	*	*

(8) Positions and faithfulness constraints tested in the experiments in this paper.

Experiment	Position	Faithfulness	Example		
1	head	segments	*piranha* + rhino	→	*piranh*o/*pir*hino
2	head	stress	*flóunder* + sardíne	→	*flóund*ine/*flound*íne
3a	noun	segments	*brood* + ridicule	→	*brood*icule/*br*idicule
4a	noun	stress	*wátch* + chóose	→	*wátch*oose/*watch*óose
3b	noun	segments	*fling* + language	→	*fling*uage/*fl*anguage
4b	noun	stress	*blúbber* + babóon	→	*blúbb*oon/*blubb*óon
5a	proper noun	segments	*chihuahua* + werewolf	→	*chihua*wolf/*chi*werewolf
6a	proper noun	stress	*jérsey* + physíque	→	*jérs*ique/*jers*íque
5b	proper noun	segments	*chihuahua* + werewolf	→	*chihua*wolf/*chi*werewolf
6b	proper noun	stress	*jérsey* + physíque	→	*jérs*ique/*jers*íque

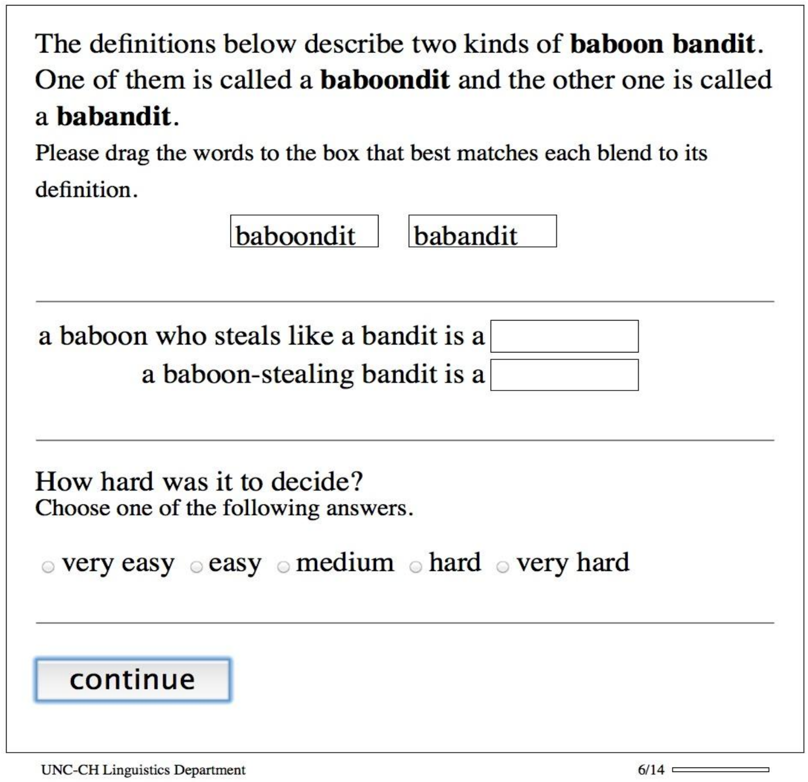

Figure 1. Appearance of a typical trial in Experiment 1.

Experiment	Condition	incomplete test	incomplete demographics	non-English first language	failed stress test
1	head/segments	2	3	0	0
2	head/stress	3	5	6	12
3a	noun/segments	5	8	1	0
4a	noun/stress	6	6	1	13
3b	noun/segments	2	1	1	0
4b	noun/stress	3	4	3	6
5a	proper noun/segments	4	5	8	0
6a	proper noun/stress	3	5	3	17
5b	proper noun/segments	1	3	7	0
6b	proper noun/stress	4	2	5	11

Table 1. Participant data collected but excluded from analysis in each experiment, separated out by reasons for exclusion. A single participant may be excluded for more than one reason.

		Participants					Birth year		
Experiment	Condition	Total	Valid	F	M	--	Min.	Med.	Max.
1	head/segments	126	123	71	52	0	1942	1983	1995
2	head/stress	132	109	58	49	2	1945	1980	1995
3a	noun/segments	127	118	69	50	0	1950	1979	1994
4a	noun/stress	144	124	73	65	0	1939	1982	1995
3b	noun/segments	128	124	69	54	3	1949	1982	1995
4b	noun/stress	134	122	62	59	0	1946	1980	1995
5a	proper noun/segments	126	112	59	53	0	1933	1982	1995
6a	proper noun/stress	155	132	63	67	1	1949	1984	1996
5b	proper noun/segments	145	135	80	55	0	1941	1982	1995
6b	proper noun/stress	155	135	77	58	0	1949	1980	1996

Table 2. Demographic data for participants in all experiments.
'F' = female, 'M' = male, '--' = no response.

Experiment	Condition	Participants		95% CI			p
		Majority -PF	Minority -PF	Min.	Est.	Max.	
1	head/segments	90	33	0.64	0.73	0.81	<0.001
2	head/stress	70	39	0.54	0.64	0.73	0.0039
3a	noun/segments	71	46	0.51	0.61	0.70	0.0261
4a	noun/stress	72	52	0.49	0.58	0.67	0.0876
3b	noun/segments	79	47	0.54	0.63	0.71	0.0055
4b	noun/stress	72	49	0.50	0.60	0.68	0.0451
5a	proper noun/segments	83	29	0.65	0.74	0.82	<0.001
6a	proper noun/stress	86	45	0.57	0.66	0.74	<0.001
5b	proper noun/segments	91	44	0.59	0.67	0.75	<0.001
6b	proper noun/stress	79	56	0.50	0.59	0.67	0.0579

Table 3. Number of participants in each experiment who gave mostly positionally-faithful vs. mostly not positionally-faithful responses. The confidence intervals and *p*-value are exact binomial.

Experiment	Condition	Intercept	s.e.	z	p	Pr (corr), 95% CI Min.	Est.	Max.
1	head/segments	0.4259	0.0836	5.096	<0.001	0.56	0.60	0.64
2	head/stress	0.3031	0.0842	3.601	<0.001	0.53	0.57	0.61
3a	noun/segments	0.2438	0.2264	1.077	0.281	0.45	0.56	0.66
4a	noun/stress	0.0684	0.0743	0.92	0.357	0.48	0.52	0.55
3b	noun/segments	0.2371	0.2549	0.93	0.352	0.43	0.56	0.67
4b	noun/stress	0.2091	0.0741	2.823	0.0476	0.52	0.55	0.59
5a	proper noun/segments	0.4355	0.1419	3.07	0.0021	0.54	0.61	0.67
6a	proper noun/stress	0.4316	0.0938	4.602	<0.001	0.56	0.60	0.65
5b	proper noun/segments	0.3115	0.1137	2.74	0.0062	0.52	0.58	0.63
6b	proper noun/stress	0.1909	0.0941	2.029	0.0425	0.50	0.55	0.59

Table 4. Fixed-effects part of the mixed logit model fit to the individual-response data in each experiment. The 95% normal confidence intervals for proportion correct were obtained by constructing an interval of radius 1.96 standard errors around the intercept, then converting it from logits to proportions.

(9) Source words, blends, and definitions used in Experiment 1. In this and subsequent corresponding examples, the blend-definition pairs are ordered so as to show the predicted pairing of blends to definitions.

Source Words		Blends	Definitions (C=coordinating; R=right-headed)	
baboon	bandit	*baboon*dit	C	a baboon who steals like a bandit
		*bab*andit	R	a baboon-stealing bandit
buccaneer	narrator	*buccaneer*rator	C	a pirate who tells stories
		*buccan*arrator	R	someone who tells pirate stories
lampoon	punishment	*lampoon*ishment	C	punishing someone by printing a lampoon
		*lamp*unishment	R	punishing someone for printing a lampoon
boutique	taxi	*boutix*i	C	a taxi with on-board boutique shopping
		*bout*axi	R	a taxi to the local boutiques
impala	polecat	*impal*cat	C	a hybrid of a polecat and an impala
		*imp*olcat	R	a polecat that hunts impalas
armadillo	dolphin	*armadil*phin	C	a hybrid of a dolphin and an armadillo
		*armad*olphin	R	a dolphin with an armadillo's leathery skin
rhododendron	dandelion	*rhododend*elion	C	a cross between a dandelion and a rhododendron
		*rhodod*andelion	R	a dandelion that grows in rhododendron-like clusters
flamingo	mongoose	*flaming*oose	C	a hybrid of a mongoose and a flamingo
		*flam*ongoose	R	a mongoose that preys on flamingos
piranha	rhino	*piran*ho	C	a hybrid of a rhino and a piranha
		*pir*hino	R	a rhino that is fierce like a piranha

Analysis	Participants: Majority-PF	Participants: Minority-PF	95% CI: Min.	95% CI: Est.	95% CI: Max.	*p*
By-participant	90	33	0.64	0.73	0.81	<0.001

(a) Number of participants in Experiment 1 who gave mostly positionally-faithful vs. mostly not positionally-faithful responses. The confidence intervals and *p*-value are exact binomial.

Analysis	Intercept	s.e.	*z*	*p*	Pr (corr), 95% CI: Min.	Pr (corr), 95% CI: Est.	Pr (corr), 95% CI: Max.
By-response	0.4259	0.0836	5.096	<0.001	0.56	0.60	0.64

(b) Fixed-effects part of the mixed logit model fit to the individual-response data in Experiment 1. The 95% normal confidence intervals for proportion correct were obtained by constructing an interval of radius 1.96 standard errors around the intercept, then converting it from logits to proportions.

Table 5. Results of Experiment 1 (repeated from Table 3 and Table 4).

(10) Source words, blends, and definitions used in Experiment 2.

Source Words		Blends	Definitions (C=coordinating; R=right-headed)	
zebra	giraffe	zébraffe	C	a cross between a giraffe and a zebra
		zebráffe	R	a giraffe with zebra stripes
robin	baboon	róboon	C	a cross between a baboon and a robin
		robóon	R	a baboon with a robin-red chest
turkey	raccoon	túrcoon	C	a cross between a turkey and a raccoon
		turcóon	R	a raccoon that steals turkey eggs
flounder	sardine	flóundine	C	a cross between a sardine and a flounder
		floundíne	R	a type of sardine eaten by flounder
bachelor	valet	báchelet	C	a valet who is also a bachelor
		bachelét	R	a valet who works for a bachelor
bistro	garage	bístrage	C	a building containing a garage and a bistro
		bistráge	R	the delivery garage of a bistro
pygmy	premier	pýgmier	C	a leader who is also a pygmy
		pygmíer	R	a leader of the pygmies
raisin	dessert	ráissert	C	a type of raisin eaten for dessert
		raissért	R	a raisin-filled dessert
lizard	gazelle	lízelle	C	a hybrid of a gazelle and a lizard
		lizélle	R	a gazelle that is scaly like a lizard

	Participants		95% CI			
Analysis	Majority-PF	Minority-PF	Min.	Est.	Max.	*p*
By-participant	70	39	0.54	0.64	0.73	0.0039

(a) Number of participants in Experiment 2 who gave mostly positionally-faithful vs. mostly not positionally-faithful responses. The confidence intervals and *p*-value are exact binomial.

					Pr (corr), 95% CI		
Analysis	Intercept	s.e.	*z*	*p*	Min.	Est.	Max.
By-response	0.3031	0.0842	3.601	<0.001	0.53	0.57	0.61

(b) Fixed-effects part of the mixed logit model fit to the individual-response data in Experiment 2. The 95% normal confidence intervals for proportion correct were obtained by constructing an interval of radius 1.96 standard errors around the intercept, then converting it from logits to proportions.

Table 6. Results of Experiment 2 (repeated from Table 3 and Table 4).

(11) Source words, blends, and definitions used in Experiment 3a.

Source words		Blends	Definitions (N=noun; V=verb)	
drain	renovate	*drain*ovate	N+V	to renovate the plumbing in your house
		*dr*enovate	V+V	to renovate your house until you bankrupt yourself
drag	regulate	*drag*ulate	N+V	to make rules about what can be worn at a drag show
		*dr*egulate	V+V	to make rules in order to drag a project out
brood	ridicule	*brood*icule	N+V	to ridicule someone's many children
		*br*idicule	V+V	to ridicule someone for sulking
creep	reprimand	*creep*rimand	N+V	to scold someone because they are a creep
		*cr*eprimand	V+V	to scold someone when they creep up on you
plot	litigate	*plot*igate	N+V	to sue a plagiarist over the plot of a novel
		*pl*itigate	V+V	to sue a conspirator when they plot against you
club	liberate	*club*erate	N+V	to release someone from a society membership
		*cl*iberate	V+V	to release a captive by bludgeoning their captors
spot	petrify	*spot*rify	N+V	to turn something to stone just in a few places
		*sp*etrify	V+V	to turn something to stone just by noticing it
break	rectify	*break*tify	N+V	to make up for a delayed paycheck with extra lunch time
		*br*ectify	V+V	to fix something in a way that actually makes it worse
storm	terminate	*storm*inate	N+V	to artificially stop a violent storm
		*st*erminate	V+V	to end a meeting when you storm out of it

(12) Source words, blends, and definitions used in Experiment 3b. Mass-noun definitions are followed by *is called*, and count-noun definitions by *is a*.

Source words		Blends	Definitions (N=noun; V=verb)	
fling	language	*fling*uage	N+N	sweet words you say during a romantic fling
		flanguage	V+N	words you carelessly fling around when angry
float	latex	*float*ex	N+N	latex that is used to waterproof a parade float
		*fl*atex	V+N	latex that is light enough to float
slip	leprechaun	*sliprechaun*	N+N	a dainty leprechaun who wears slips
		sleprechaun	V+N	a clumsy leprechaun who often slips
spell	policy	*spell*icy	N+N	a policy about how to cast a spell
		*sp*olicy	V+N	a policy about how to spell words
clog	laggard	*cloggard*	N+N	a slow-moving person who wears clogs
		claggard	V+N	a slow-moving person who clogs the stairwell
creep	reptile	*creep*tile	N+N	a reptile that has a sleazy personality
		*cr*eptile	V+N	a reptile that sneaks along the ground
crop	replica	*crop*lica	N+N	an exact duplicate of a farmer's harvest
		*cr*eplica	V+N	a duplicate which has been trimmed down
block	licorice	*block*orice	N+N	licorice that comes in a block
		*bl*icorice	V+N	licorice likely to block your intestines
grouse	restaurant	*grouse*terant	N+N	a restaurant where you can eat grouse
		*gr*estaurant	V+N	a restaurant that dissatisfied people grouse about

(13) Source words, blends, and definitions used in Experiment 4a.

Source words		Blends	Definitions (N=noun; V=verb)	
watch	choose	*wátch*oose	N+V	to pick out a watch
		*watch*óose	V+V	to decide to watch
blubber	boast	*blúbb*oast	N+V	to boast of how your crew brought back so much blubber
		*blubb*óast	V+V	to boast of how you made a younger child blubber
ship	prepare	*shíp*are	N+V	to prepare a ship for something
		*ship*áre	V+V	to prepare to ship something
trip	repent	*tríp*ent	N+V	to repent after a trip you took
		*trip*ént	V+V	to repent after you trip someone
spell	learn	*spéll*earn	N+V	to learn a magic spell
		*spell*éarn	V+V	to learn to spell
fudge	reject	*fúdg*ect	N+V	to refuse to eat any fudge
		*fudg*éct	V+V	to refuse to fudge a calculation
prune	enjoy	*prúne*joy	N+V	to enjoy dried plums
		*prune*jóy	V+V	to enjoy trimming shrubbery
train	announce	*tráino*unce	N+V	to announce railway arrivals
		*train*óunce	V+V	to announce that you will be working out
jam	permit	*jám*it	N+V	to permit sweet fruit preserves
		*jám*ít	V+V	to permit musicians to improvise

(14) Source words, blends, and definitions used in Experiment 4b. Mass-noun definitions are followed by *is called*, and count-noun definitions by *is a*.

Source words		Blends	Definitions (N=noun; V=verb)	
blubber	baboon	*blúbb*oon	N+N	a baboon with extra body fat
		*blubb*óon	V+N	a baboon that weeps noisily
spell	alarm	*spéll*arm	N+N	an alarm that beeps when you cast a magic spell
		*spell*árm	V+N	an alarm that beeps when you spell words badly
train	technique	*tráin*ique	N+N	a technique for getting seats on a train
		*train*íque	V+N	a technique that runners use to train
flounder	ordeal	*flóund*eal	N+N	a medieval witchcraft test, trial by flounder
		*flound*éal	V+N	humiliation on the witness stand when you flounder
hail	lamp	*háil*amp	N+N	a signal lamp warning ships of hail
		*hail*ámp	V+N	a signal lamp lit to hail a ship
jam	remorse	*jám*orse	N+N	remorse when you ate too much jam
		*jam*órse	V+N	remorse when you didn't jam with your band
bug	brigade	*búg*ade	N+N	an organized force that exterminates bugs
		*bug*áde	V+N	an organized force that really bugs people
bowl	delight	*bówl*ight	N+N	delight when you make a perfect bowl
		*bowl*íght	V+N	delight when you bowl a perfect game
slug	disgust	*slúg*ust	N+N	disgust when you feel a slug on you
		*slug*úst	V+N	disgust that makes you want to slug someone

Analysis: By-participant	Participants		95% CI			p
	Majority-PF	Minority-PF	Min.	Est.	Max.	
3a (segments)	71	46	0.51	0.61	0.70	0.0261
4a (stress)	72	52	0.49	0.58	0.67	0.0876
3b (segments)	79	47	0.54	0.63	0.71	0.0055
4b (stress)	72	49	0.50	0.60	0.68	0.0451

(a) Number of participants in Experiments 3a, 4a, 3b, and 4b who gave mostly positionally-faithful vs. mostly not positionally-faithful responses. The confidence intervals and p-value are exact binomial.

Analysis: By-response	Intercept	s.e.	z	p	Pr (corr), 95% CI		
					Min.	Est.	Max.
3a (segments)	0.2438	0.2264	1.077	0.281	0.45	0.56	0.66
4a (stress)	0.0684	0.0743	0.92	0.357	0.48	0.52	0.55
3b (segments)	0.2371	0.2549	0.93	0.352	0.43	0.56	0.67
4b (stress)	0.2091	0.0741	2.823	0.0476	0.52	0.55	0.59

(b) Fixed-effects part of the mixed logit model fit to the individual-response data in Experiments 3a, 4a, 3b, and 4b. The 95% normal confidence intervals for proportion correct were obtained by constructing an interval of radius 1.96 standard errors around the intercept, then converting it from logits to proportions.

Table 7. Results of Experiments 3a, 4a, 3b, and 4b (repeated from Table 3 and Table 4).

(15) Source words, blends, and definitions used in Experiments 5a and 6a.

Source words		Blends	Definitions (N=proper noun; n=common noun)	
bohemian	hummus	*bohemm*us	N+n	Dip made by a native Bohemian from the Czech Republic.
		*boh*ummus	n+n	Dip made by an artsy bohemian in Greenwich Village.
soprano	preening	*sopran*ing	N+n	Preening by New Jersey mobsters on HBO.
		*sopr*eening	n+n	Preening by female opera singers on stage.
cologne	linen	*cologn*en	N+n	Linen made in Cologne, Germany.
		*col*inen	n+n	Linen scented with cologne.
canary	nursery	*canar*sery	N+n	A nursery in the Canary Islands.
		*can*ursery	n+n	A nursery for canary breeding.
chihuahua	werewolf	*chihuaw*olf	N+n	A werewolf who is from Chihuahua, Mexico.
		*chiw*erewolf	n+n	A werewolf who, in wolf form, resembles a chihuahua.
superior	parrot	*superr*ot	N+n	A talking bird native to the shores of Lake Superior.
		*sup*arrot	n+n	An employee who will mindlessly mimic their superior.
independence	pundit	*independ*it	N+n	A pundit who lives in Independence, Missouri.
		*indep*undit	n+n	A pundit who speaks out in support of independence.
crusade	soda	*crusad*a	N+n	A bubbly drink brought back to Europe from the Fourth Crusade.
		*crus*oda	n+n	A sugar-free drink promoted during a health crusade.
narcissus	saucer	*narciss*er	N+n	A saucer with a picture of Narcissus admiring himself.
		*nars*aucer	n+n	A saucer with a picture of a narcissus plant in bloom.

(16) Source words, blends, and definitions used in Experiments 5b and 6b.

Source words		Blends	Definitions (N=proper noun; n=common noun)	
turkey	tycoon	*túrc*oon	N+n	Someone who made a lot of money in Turkey.
		*turc*óon	n+n	Someone who made a lot of money in turkey.
jersey	physique	*jérs*ique	N+n	A physique that looks right for New Jersey.
		*jers*íque	n+n	A physique that looks right for a jersey.
sparrow	terrain	*spárr*ain	N+n	Terrain where you're likely to encounter Captain Jack Sparrow.
		*sparr*áin	n+n	Terrain where you're likely to encounter a swamp sparrow.
buffalo	affair	*búff*air	N+n	A mysterious affair involving Buffalo, New York.
		*buffá*ir	n+n	A mysterious affair involving a buffalo herd.
china	canal	*chín*al	N+n	A canal constructed for transport in China.
		*chin*ál	n+n	A canal constructed for the transport of china.
hamlet	delay	*háml*ay	N+n	A delay caused by agonizing indecision, like in Hamlet.
		*haml*áy	n+n	A delay caused by the slow pace of life in a rural hamlet.
potter	cartel	*pótt*el	N+n	A monopoly controlling the right to works about Harry Potter.
		*pott*él	n+n	A monopoly controlling the right to work as a potter.
boulder	sedan	*bóuld*an	N+n	A kind of sedan made in Boulder, Colorado.
		*bould*án	n+n	A kind of sedan made to climb over boulders.
homer	dismay	*hóm*ay	N+n	Dismay when you're assigned to read Homer again.
		*hom*áy	n+n	Dismay when the other team's batter hits a homer again.

Analysis: By-participant	Participants		95% CI			
	Majority-PF	Minority-PF	Min.	Est.	Max.	p
5a (segments)	83	29	0.65	0.74	0.82	<0.001
6a (stress)	91	44	0.59	0.67	0.75	<0.001
5b (segments)	86	45	0.57	0.66	0.74	<0.001
6b (stress)	79	56	0.50	0.59	0.67	0.0579

(a) Number of participants in Experiments 5a, 6a, 5b, and 6b who gave mostly positionally-faithful vs. mostly not positionally-faithful responses. The confidence intervals and *p*-value are exact binomial.

Analysis: By-response	Intercept	s.e.	z	p	Pr (corr), 95% CI		
					Min.	Est.	Max.
5a (segments)	0.4355	0.1419	3.07	0.0021	0.54	0.61	0.67
6a (stress)	0.3115	0.1137	2.74	0.0062	0.52	0.58	0.63
5b (segments)	0.4316	0.0938	4.602	<0.001	0.56	0.60	0.65
6b (stress)	0.1909	0.0941	2.029	0.0425	0.50	0.55	0.59

(b) Fixed-effects part of the mixed logit model fit to the individual-response data in Experiments 5a, 6a, 5b, and 6b. The 95% normal confidence intervals for proportion correct were obtained by constructing an interval of radius 1.96 standard errors around the intercept, then converting it from logits to proportions.

Table 8. Results of Experiments 5a, 6a, 5b, and 6b (repeated from Table 3 and Table 4).