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Competing Semantic and Phonological Constraints in Novel Binomials

Eli George
Western Washington University

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Eli George
Advised by Dr. Jordan Sandoval
Western Washington University

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1. INTRODUCTION. Binomials are pairs of words, often of the same grammatical category, that are frequently found alongside one another. Examples in English include "salt and pepper," "mom and dad," or "rock and roll." A frozen binomial is a pair of words that not only often appear together, but that consistently appear in the same order. Each of the three examples above is considered a frozen (or sometimes, "irreversible") binomial. Brief preliminary testing has revealed that English speakers find the reverse of these frozen binomials ("pepper and salt," "dad and mom," "roll and "rock") not nearly as well-formed as their "correctly" ordered counterparts. But then a question arises: why are these, and so many other binomials, frozen in a particular order?

2. BACKGROUND. This question has been approached by countless linguists throughout the history of the discipline—examinations of binomials range as far back as the ancient Sanskrit philologist Panini. However, the bedrock of the modern study of binomials is a 1975 study carried out by Cooper and Ross. In said study, a number of semantic and phonological constraints were found—constraints that dictated the order in which binomials were more likely to appear, as well as the order in which they were more likely to freeze. In general, the semantic constraints were summed up in the "Me First" principle; that is, the word that the speaker can empathize with most will come first. Cooper and Ross further broke this down into twenty-two specific constraints, a few of which are summarized below:

Figure 2.1: Semantic binomial constraints as proposed by Cooper and Ross (1975)

Constraint	Examples

Living	"The quick and the dead," "life or death"
Male/Gender	"Son and daughter," "Romeo and Juliet"
Here	"This and that," "Here and there"
Patriotic	"Cowboys and Indians," "U.S.-Canadian border"
Adult/Age	"Father and son," "mother and daughter"

Cooper and Ross also found a number of phonological constraints. These phonological constraints vary greatly, but are summed up by placing the "heavier" (longer, lower, more obstruent, more phonologically complex) word last. Crucially, these phonological constraint are hierarchical; if two phonological constraints both apply, the one listed first on the following table is prioritized:

Figure 2.2: Phonological constraints a proposed by Cooper and Ross (1975)

Constraint	First word will have:	Examples
Number of syllables (Panini's Law)	Fewer syllables	"Live and let die," "stuff and nonsense"
Vowel length	Shorter vowels	"Stress and strain," "mom and dad"
Number of initial consonants	Fewer word-initial consonants	"Helter-skelter," "fair and square"
Quality of initial consonant	More sonorant initial consonant	"Huff and puff," "namby-pamby"
Vowel quality	Lower first formant	"Drip, drop," "flip-flop"

Number of final consonants	More word-final consonants	"Betwixt and between"
Quality of final consonant	Less sonorant word-final consonant	"Kith and kin," "push and pull"

Numerous subsequent studies have revised the original Cooper and Ross study. Renner (2014) points out that the constraints of *Here* and *Patriotic* could easily be combined into a single constraint of *Spatial closeness*. Wright, Hay, and Bent (2005) performed an experiment showing that the *Male* constraint can often be explained simply by the relation phonological constraints have with the sounds more prevalent in male names. Pinker and Birdsong (1979), along with the other previously mentioned studies, cite numerous counter-examples to Cooper and Ross' initial claims. For example "dead or alive" ignores *Living*. However, it should be noted that "dead or alive" *does* follow *Panini's law*, that is, the constraint suggesting the word with fewer syllables comes first. This, perhaps, suggests that *Panini's law*, a phonological constraint, takes precedence over *Living*, a semantic constraint.

Pinker and Birdsong (1979) performed research that not only rigorously justified the order of the phonological rules, but disproved those for which insufficient evidence was available (such as *Number of final consonants*). Other experiments, namely Campbell and Anderson (1976) have suggested that the meter and stress pattern of the two words (and the insertion of a conjunction) are the principle determiners of binomial ordering. Fenk-Oczlon (1989) instead posits that it is merely the more frequent word that appears first.

There are a few key studies that have attempted to reconcile these various constraints. Mollin (2011) examines the reversibility of binomials (an area that had previously been overlooked) and comes up with a crucial ordering of what categories of constraints were more likely to be followed. This research found that semantic constraints had the most influence over word ordering, followed by metric constraints, word frequency, and finally phonological constraints. Part of what makes Mollin (2011) unique among binomial studies is the fact that it looks not just at the constraints themselves, but how they contribute to the freezing process.

That said, there are many ways to examine the freezing process. Pinker and Birdsong (1979) did this by creating novel binomials and looking at how participants choose to order them. Such an experiment has the advantage of looking at frozen binomial formation as it happens, rather than inferring it from a pre-existing corpus. Furthermore, the use of novel words allows for a fine control of the constraints in play. Pre-existing binomials often have multiple constraints affecting their ordering—a constraint like word frequency is universally applied to all binomials—which creates a lot of "noise." By using novel words, the irrelevant constraints can be easily filtered out of the analysis.

This present study seeks to examine both phonological and semantic constraints in novel binomials, in an attempt to come up with some crucial ordering similar to that proposed by Cooper and Ross (1975). Thus, this experiment uses a methodology similar to that of Pinker and Birdsong (1979) but, like Mollin (2011), examines both phonological *and* semantic constraints.

3. METHODOLOGY.

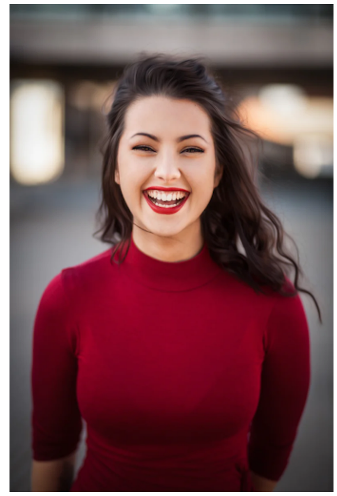
Like Pinker and Birdsong (1979), this study presents subjects with novel word pairs and asks them to choose the order that seems best. The key difference is that, in addition to phonological information (provided by the orthographic representation and audio recording of the word), semantic information is provided in the form of a stock image. As this is more of a preliminary study, only two of each type of constraint (phonological and semantic) were chosen for examination. The phonological constraints were *Panini's law* (or *Syllables*) and *Vowel quality*, and the semantic constraints were *Adult* (or *Age*) and *Male* (or *Gender*).

3.1. PARTICIPANTS. The participants were thirty-eight literate English speakers. All were contacted through an introductory linguistics course at Western Washington University. Participants were compensated with additional course credit.

3.2. MATERIALS. The experiment itself was, in essence, a computer survey that presented participants with two stock images of people, as well as two words. They were told that these images and words were the portraits and names of people. Audio recordings of the names being spoken were also presented.

Below are two examples of what the subjects might see:

Figure 3.1: *Number of syllables* vs *Adult*



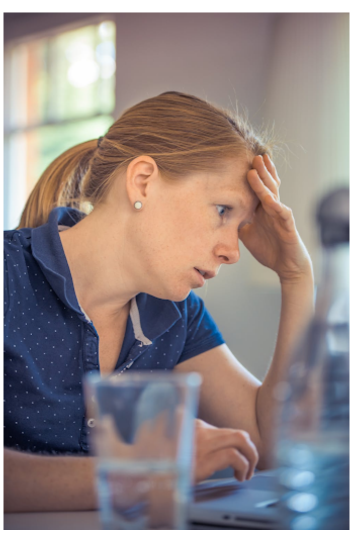
DEEJA ATEEJAH

"I saw ____ and _____."

Ateejah and Deeja

Deeja and Ateejah

Figure 3.2: *Vowel Quality* vs *Male*



AEFRIG OFRIG

"I saw _____ and _____."

Ofrig and Aefrig

Aefrig and Ofrig

In each of these examples, a semantic constraint and a phonological constraint are in play. Crucially, the constraints are organized such that the phonological constraint suggests one order for the words, while the semantic constraint suggests the opposite order.

In the first example, if the *Adult* constraint took priority, then the "Ateejah and Deeja" option would be chosen. If *Panini's Law* took priority, then the "Deeja and Ateejah" option would be selected. In the second example, "Aefrig and Ofrig" prioritizes *Vowel quality*, while "Ofrig and Aefrig" prioritizes *Male*. Thus, the semantic and phonological constraints were put in competition with each other. Furthermore, different combinations of semantic and phonological constraints are tested. That is, the *Vowel quality* phonological constraint in Figure 3.2 is tested against the *Adult* semantic constraint, as well as *Male*. Note that semantic constraints are not tested against other semantic constraints, nor phonological against phonological. Most other research relating to binomials has compared constraints of similar types, namely Pinker and Birdsong (1979) and Renner (2014), or examined binomials in which only one constraint is relevant, like Cooper and Ross (1975). This experiment instead aims to compare constraints of differing types.

The other types of constraints outlined by Mollin (2011) are not present in these questions—in the case of novel words, word frequency cannot logically have an effect. While metric constraints could have an effect, the phonological stimuli was specifically selected so that stressed syllables would never be placed adjacent to one another, or more than two syllables apart, so as to match standard American English prosody.

To avoid any other influences on the responses, the frame sentence "I saw ____ and ____." was used for each question. However, the combinations of phonological and semantic stimuli were randomized for each participant. That is, the pairs of words themselves were consistent (e.g. "Aefrig" always appeared with "Ofrig") and the image pairs were always consistent, but the image pairs and word pairs were not always matched up the same way for each participant.

Moreover, because of the limitations of the program used to design the experimental survey, each word and image pair was always presented to the subject with the same orientation on the screen (that is, "Deeja" will always appear on the left, and "Ateejah" on the right). As in the examples presented above, the top response was always "[right word] and [left word]" and vice versa for the bottom response. Because of these limitations, not every slide actually presented a conflict of constraints. However, in practice, roughly a third of the questions produced conflicting constraints, thus providing nearly one hundred data points for each combination of constraints.

Twenty-five pairs of words/images were created for each constraint, and ten pairs were created in which none of the target constraints were in play—that is, there were ten pairs of words in which there was no difference in number of syllables or vowel quality, and ten pairs of images in which there was no discernable difference in age or gender. These extra pairs functioned as control questions, where only a semantic *or* phonological constraint would be present, rather than both. Thus there were sixty questions in total presented to the subjects.

The novel words were constructed such that they only varied along the constraint in question. Unstressed syllables were reduced to /ə/, and though the consonants varied between the two words in a pair, they were nonetheless similar in place and manner. Likewise, stock photos were chosen so that the only major differences between the individuals were the constraints being tested—other features, such as skin and hair color, were kept consistent between both images in a pair.

3.3. PROCEDURE. The experiment was performed in a quiet sound booth on the Western Washington University campus. Subjects were not asked to provide any personal information other than their name for the purpose of receiving additional course credit, and an email if they wished to receive updates on the experiment as it was developed.

Subjects beginning the experiment were shown the following instructions:

On the following slides, you will see images of two people, with their names beneath the images. Use the buttons to choose the order for the names that seems better when put into the frame sentence "I saw ______ and _______."

Each subject was given thirty minutes total to answer all sixty questions. This time limit is imposed for both logistical convenience and in an attempt to elicit natural speech patterns. Participants were provided with headphones, over which a recording of the two names were played. They were also permitted to say the options aloud to themselves. After the final question, subjects were told to remove their headphones and inform the research proctor that they had finished. The experimental stimuli were created and displayed using E-Prime.

4. DATA AND RESULTS. Of the thirty-eight participants, data from roughly twenty was considered unusable. Each question automatically played a three-second audio clip of the names being spoken—if any response times were faster than three seconds, it indicated the subject did not listen to the entire audio clip, and therefore may not have had an accurate phonological representation of both words. Thus, data from participants with average response times of less than four seconds or more than nine seconds was excluded. Furthermore, some participants consistently chose the same button to respond each time, likely because they did not fully understand the instructions. Any data from a subject who answered the same response more than 75% of the time was removed.

In the end, only about half of the data was considered usable. Of this, there were 343 questions in which conflicting semantic and phonological constraints occurred. Of these, there were 87 instances of *Vowel quality* conflicting with *Age*, 97 instances of *Vowel quality* conflicting with *Gender*, 81 instances of *Number of syllables* conflicting with *Age*, and 78 instances of *Number of syllables* conflicting with *Gender*.

Figure 4.1: Percentages of preferred constraint

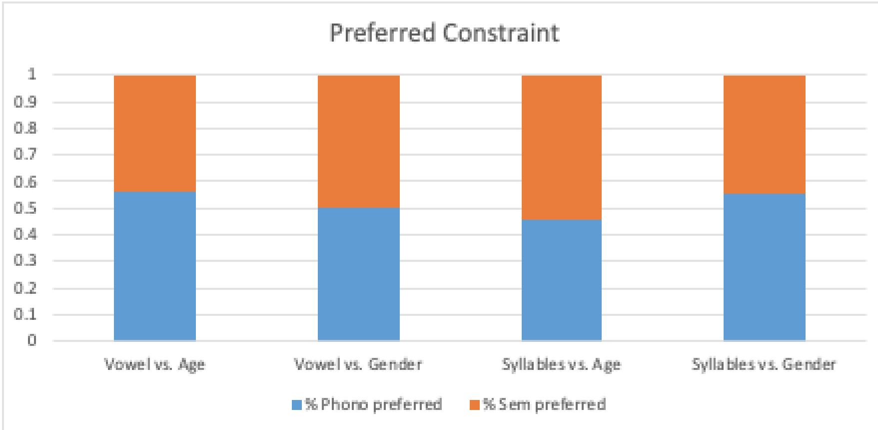
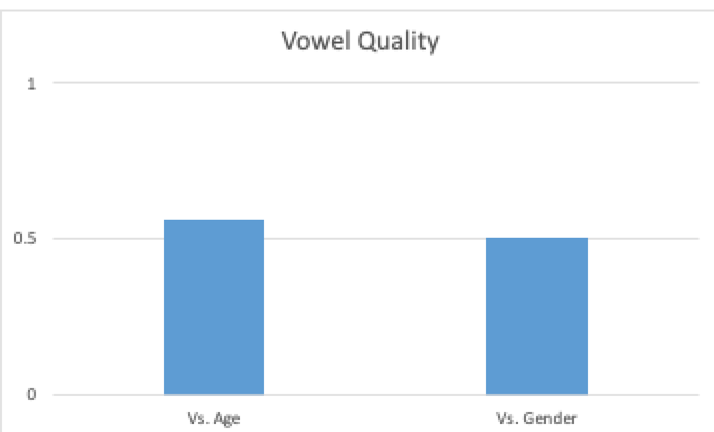
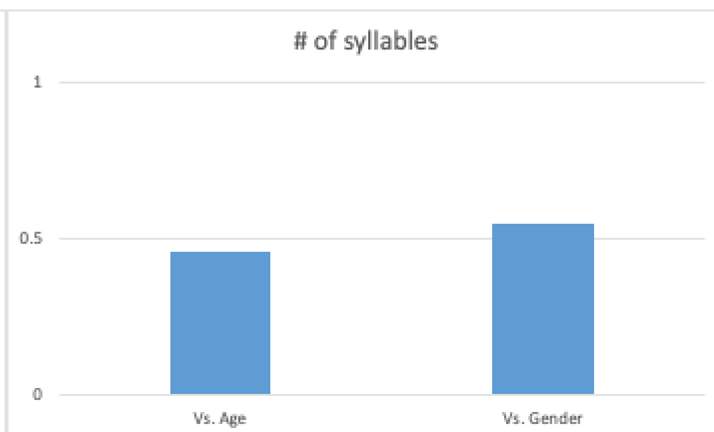


Figure 4.2: Percentages of preferred constraint

Constraints	% Phono preferred	% Sem preferred
Vowel vs. Age	0.563218391	0.436781609
Vowel vs. Gender	0.505154639	0.494845361
Syllables vs. Age	0.456790123	0.543209877
Syllables vs. Gender	0.551282051	0.448717949

Figure 4.3: Phonological constraint preferences compared to semantic constraints.





As Figures 4.1-4.3 indicate, *Vowel quality* was chosen over *Age* in 56% of cases, and was chosen over *Gender* in roughly half of the cases. *Age* was chosen over *Syllables* in roughly 54% of cases, and *Syllables* was chosen over *Gender* in 55% of cases.

5. CONCLUDING REMARKS. Although a more rigorous statistical analysis could not be performed before the publication of these results, some conclusions can be drawn. First, it appears that subject preferences tended to lean towards prioritizing phonological constraints, as half of the possible combinations favored the phonological constraint, while only one out of four noticeably favored the semantic constraint. This is odd, especially in the context of pre-existing research. Mollin (2011) suggests that, in pre-existing English binomials, semantic constraints are far more salient than phonological. These differing results could perhaps be explained by the use of novel words in the present experiment. Seeing an image and a word on a screen for a few seconds is likely not enough time to create a strong semantic definition for the word. Future experiments could address this by spending more time with individual subjects, so as to teach them novel words to the point of fluency.

Secondly, some contradictions arise if one attempts to use these results to form an ordered hierarchy of constraints. Looking at how *Syllables* compared with the two semantic rules, it appears that *Age* has more importance than *Syllables*, which in turn has more importance than *Gender*, suggesting the following order:

Age > *Syllables* > *Gender*

Looking at *Vowel quality* now, the following hierarchy could be suggested:

Vowel quality = *Gender* > *Age*

That is, *Vowel quality* is only prioritized over *Gender* about half of the time, but is prioritized over *Age*. These possible orders are odd, though. The former suggests that *Age* can be ranked higher than *Gender*, but the latter suggests the opposite. Moreover, the former places *Age* higher than *Syllables*, and the latter places *Vowel quality* higher than *Age*, which would imply that *Vowel quality* takes precedence over *Syllables*—something that goes against almost all pre-existing research.

That said, there is still some that can be learned from this data. First, the data demonstrates the inherent difficulty of providing semantic meaning to names using only images. Second, and perhaps more importantly, this data suggests that there may be a far more complex underlying hierarchy of binomial constraints than a simple linear order. That is, the hierarchy may change significantly depending on any number of other factors, forming a dynamic system that certainly warrants further investigation.

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