



## Deseret Language and Linguistic Society Symposium

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Volume 26 | Issue 1

Article 18

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4-7-2000

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David Bowie

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Bowie, David (2000) "Perception and Production in Processes of Merger," *Deseret Language and Linguistic Society Symposium*: Vol. 26 : Iss. 1 , Article 18.

Available at: <https://scholarsarchive.byu.edu/dlls/vol26/iss1/18>

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# Perception and Production in Processes of Merger

David Bowie

In 1972, Labov, Yaeger, and Steiner noted the existence of what have been called “apparent mergers” or “near-mergers”—cases in which vowel classes are produced differently by members of a speech community but at the same time are perceived by them as being the same.<sup>1</sup> Since then, several studies have confirmed that near-mergers do exist (for example Janson and Schulman 1983; Di Paolo and Faber 1990; Labov, Karan, and Miller 1991; Kontra 1993; Faber and Di Paolo 1995; Diehm and Johnson 1997).<sup>2</sup> In addition, evidence has been found that similar effects can be found in second language acquisition (Sheldon and Strange 1982) and that the concept can be used to explain certain puzzling phenomena in historical linguistics (Nunberg 1980). It should be noted that the evidence listed here is evidence for a rather counterintuitive proposal, as it posits that speakers are able to produce contrasts they are unable to hear.

This paper presents a report of results from fieldwork in Waldorf, a medium-sized town in Southern Maryland, in order to confirm whether mergers in perception actually do precede mergers in production in the linguistic situation there. Waldorf is a community of 51,324 people located twenty-three miles south-southeast of Washington, D.C. (Charles County Economic Development Commission 1998);<sup>4</sup> it has historically been a rural community but is in the process of changing into a suburban one. Previous dialectological studies have placed Waldorf either in the Southern dialect region or at the

border of the Southern and Midland regions, and there is in fact disagreement among Waldorfians themselves as to whether their accent sounds more “Southern” or “Northern.” This town was chosen as the site for the current study in part because previous fieldwork there had shown that there are mergers in progress among the pre-lateral non-low back vowels (that is, the vowels in the words *pole*, *pull*, and *pool*).<sup>5</sup> The vowels in these words have only been found to be merged in the pre-lateral context in Waldorf; this is unsurprising, as following /l/ is a context that seems to promote merger (Ash 1998, among others).<sup>6</sup> This situation presents an opportunity to test the hypothesis that mergers in perception precede mergers in production not just in situations where the merger is universal, but also in which it is a conditioned merger.

Fieldwork among Waldorfians was conducted between the spring of 1998 and the fall of 1999. In this study, twenty-nine native Waldorfians underwent commutation tests to determine the progress of the mergers in the pre-lateral non-low back vowels in both perception and production. The subjects took a series of three commutation tests, each comparing a minimal pair with different pre-lateral non-low back vowels in order to determine the presence or absence of mergers in perception—so the subjects were each recorded reading three randomly ordered lists of thirty words, each made up of minimal pairs of the words under study (*pole/pull*, *pull/pool*, and *pole/pool*). After

this, demographic information was obtained from the subjects, and they then listened to the recording of their own voices reading the minimal pair lists. The subjects were asked to mark down which word they believed they heard themselves saying while listening to the tape; a preprinted form with checkboxes was provided for this purpose. The subjects heard only twenty words from each list, as the tape was not started at the beginning of each list. In this way, the remote but real danger of the subjects having simply memorized the list while reading it and marking down the answers accordingly was eliminated.<sup>7</sup>

After the commutation tests were completed, the answers given by the subjects as to what they believed they heard were checked against a master list. If a subject correctly identified all of the words in a particular minimal pair list, then that subject was identified as not having a merger in perception for that pair. On the other hand, if the subject misidentified any of the words in a particular list, that person was identified as having a merger in perception in pre-lateral environments for the vowel pair in question.<sup>8</sup> In addition, the words rated by the subjects in the commutation tests were put through a linear predictive coding analysis<sup>9</sup> to provide first and second formant values for each utterance to determine the existence of mergers in production using F1-F2 plots. In this way, the same utterances were tested for evidence of merger in perception and production, and the danger of differences due to style or setting was avoided.

Looking at the results of the testing for mergers in perception using apparent time reveals that the mergers have proceeded in a particular order in this speech community—first *pull* and *pool* merged, then shortly thereafter *pull* and *pole* merged, and finally the merger of *pole* and *pool* took place. This is shown in Table 1, which gives the results for merger in perception for each of the pairs

tested, arranged by the year of birth of the subjects from oldest to youngest. Note that in this table (as in other tables in this paper that use a merged/distinct classification) *merged* means that the items at the top of the column have collapsed together to such an extent that they are rated as merged, while *distinct* means that they are not merged. (The purpose of the heavy line dividing the columns of the table in two will become apparent as the paper continues.)

Table 1 shows that, while there was some individual variation before (and in some cases after) each merger took hold completely, the most significant difference in the perception of *pull* and *pole* exists between those born in 1963 or earlier and those born in 1965 or later.<sup>10</sup> For *pull* and *pool*, the most significant split occurs between those born in 1957 or earlier and those born in 1960 or later,<sup>11</sup> and the merger of *pool* and *pole* shows a significant split between those born in 1978 and earlier and those born in 1979 and later.<sup>12</sup>

Rating the production of mergers is not quite as clear-cut, as production as measured by F1-F2 plots is an analog rather than a digital system—that is, it's the result of the relevant placement of several produced phonemes rather than a single merged/distinct rating for the entire group. For the purposes of the current paper, however, a system was set up to make rating the subjects' production as binary as possible while still mathematically rigorous. The first and second formant values of each set of produced vowels were subjected to a Student's *t* test with a null hypothesis that the vowels were merged in production. If the results of this statistical measure gave a value of  $p < 0.05$ , a standard cutoff value for this sort of testing, for either formant, the vowels were considered to be distinct in production. A summary of the results for merger in production for all of the individuals listed in Table 1 is given in Table 2.

Table 1. Status of Mergers in Perception by Subject

Pseudonym	Sex	Year of birth	pull-pole	pull-pool	pool-pole
Theona	f	1919	merged	merged	distinct
Elden	m	1921	merged	merged	distinct
Rowan	f	1929	distinct	distinct	distinct
Gerald	m	1941	distinct	merged	distinct
Randall	m	1942	distinct	merged	merged
Elise	f	1946	merged	merged	merged
Raymond	m	1948	merged	merged	distinct
Jeri	f	1951	merged	distinct	distinct
Pippin	m	1951	merged	distinct	distinct
Melina	f	1954	merged	merged	merged
Bo	m	1956	merged	distinct	distinct
Paulie	f	1957	merged	distinct	distinct
Tex	m	1960	merged	merged	distinct
Rosa	f	1963	distinct	merged	distinct
Roy	m	1965	merged	distinct	distinct
Niels	m	1966	merged	merged	distinct
Torren	m	1967	merged	merged	distinct
Blake	f	1969	merged	merged	distinct
Charles	m	1969	merged	merged	merged
Capri	f	1971	merged	merged	distinct
Dayne	m	1973	merged	merged	distinct
Joanne	f	1977	merged	merged	distinct
Helen	f	1978	merged	merged	distinct
Deanna	f	1979	merged	merged	merged
Dawson	m	1980	merged	merged	merged
Gus	m	1982	distinct	merged	distinct
Kelly	f	1986	merged	merged	merged
Cherokee	f	1988	merged	merged	distinct
Thane	m	1988	merged	merged	merged

The most obvious thing that jumps out of Table 2 is that there is much less merger in production than there is merger in perception.<sup>13</sup> Also, the splits separating the speech community's adoption of these mergers in perception do not precisely match the speech community's adoption of the mergers in production. The most significant difference in production of *pull* and *pole* appears between those born in or before 1967 and those born later<sup>14</sup> (as compared to the

perceptual merger, which was adopted slightly earlier, beginning with those born in 1965). The difference in merging *pull* and *pool* in production occurs between those born in 1967 and earlier on the one hand and those born in 1969 and later on the other<sup>15</sup> (later than the parallel merger in perception, which was adopted beginning with those born in 1960). The adoption of the merger in production of *pole* and *pool*, it should be noted, does not lend itself well to statistical testing (and

Table 2: Status of Mergers in Production by Subject

Pseudonym	Sex	Year of birth	pull-pole	pull-pool	pool-pole
Theona	f	1919	distinct	<b>merged</b>	distinct
Elden	m	1921	distinct	distinct	distinct
Rowan	f	1929	distinct	distinct	distinct
Gerald	m	1941	distinct	distinct	distinct
Randall	m	1942	distinct	distinct	distinct
Elise	f	1946	<b>merged</b>	distinct	distinct
Raymond	m	1948	distinct	distinct	distinct
Jeri	f	1951	<b>merged</b>	distinct	distinct
Pippin	m	1951	distinct	distinct	distinct
Melina	f	1954	distinct	distinct	distinct
Bo	m	1956	distinct	distinct	distinct
Paulie	f	1957	distinct	distinct	distinct
Tex	m	1960	distinct	distinct	distinct
Rosa	f	1963	distinct	distinct	distinct
Roy	m	1965	distinct	distinct	distinct
Niels	m	1966	distinct	distinct	distinct
Torren	m	1967	<b>merged</b>	distinct	distinct
Blake	f	1969	<b>merged</b>	distinct	distinct
Charles	m	1969	<b>merged</b>	<b>merged</b>	distinct
Capri	f	1971	distinct	distinct	distinct
Dayne	m	1973	distinct	distinct	distinct
Joanne	f	1977	distinct	distinct	distinct
Helen	f	1978	<b>merged</b>	<b>merged</b>	<b>merged</b>
Deanna	f	1979	<b>merged</b>	distinct	distinct
Dawson	m	1980	distinct	distinct	distinct
Gus	m	1982	distinct	distinct	distinct
Kelly	f	1986	distinct	distinct	distinct
Cherokee	f	1988	<b>merged</b>	<b>merged</b>	distinct
Thane	m	1988	<b>merged</b>	distinct	distinct

therefore to comparison with the adoption of the merger in perception) because the only person who exhibits the merger is Helen (born 1978).

A comparison of Tables 1 and 2 reveals that there is often a mismatch between production and perception among those tested. A table showing where the status of each merger matched or differed is given in Table 3, where a *D* represents a distinction in both production and perception, an *M* indicates a merger in both perception and production, production indicates a merger in *production* but not perception, and *perception* indicates a merger in perception but not production.

One thing to note in Table 3 is that, once a merger progresses through both perception and production, it is almost never completely reversed in both perception and production.<sup>16</sup> This only makes sense—these are processes of merger, and reversal of merger is an extraordinary occurrence.

Another thing that comes out of Table 3 is that, although the perception and production of the various mergers and distinctions does match in the majority of cases, there are still a large number of cases in which there is a mismatch. Most notably, however, of the forty-three cases of a mismatch between perception and production, only *one* of them shows a

merger in production and not perception (Helen's *pool* and *pole*). This in itself is quite suggestive evidence that merger in perception generally precedes merger in production in this speech community. The one odd exception will not be dealt with in this paper, but it has been dealt with in other reports on this data (Bowie 2000) and turns out not to be evidence against the claim that mergers in production are temporally following corresponding mergers in perception in this speech community.

So after all this discussion, the question remains—what does all this mean? In answer, the most obvious thing to

report from this study is that yet another case has been found in which mergers in perception precede mergers in production temporally, thus providing still more evidence that this is a general process by which mergers spread. The data that has been presented, however, shows some items of interest that go beyond that.

The first of these is something brought up in previous work on similar issues (Bowie 1998, 1999)—a methodological caution. This study simply compared results for perception with a simple test for merger in production (such as, for example, F1-F2 plots or native speaker judgments). A moment's reflection will show that this is a dangerous

Table 3. Mergers in Perception and Production by Subject

Pseudonym	Sex	Year of birth	pull-pole	pull-pool	pool-pole
Theona	f	1919	<i>perception</i>	M	D
Elden	m	1921	<i>perception</i>	<i>perception</i>	D
Rowan	f	1929	D	D	D
Gerald	m	1941	D	<i>perception</i>	D
Randall	m	1942	<i>perception</i>	<i>perception</i>	D
Elise	f	1946	M	<i>perception</i>	<i>perception</i>
Raymond	m	1948	<i>perception</i>	<i>perception</i>	D
Jeri	f	1951	M	D	D
Pippin	m	1951	<i>perception</i>	D	D
Melina	f	1954	<i>perception</i>	<i>perception</i>	<i>perception</i>
Bo	m	1956	<i>perception</i>	D	D
Paulie	f	1957	<i>perception</i>	D	D
Tex	m	1960	<i>perception</i>	<i>perception</i>	D
Rosa	f	1963	D	<i>perception</i>	D
Roy	m	1965	<i>perception</i>	D	D
Niels	m	1966	<i>perception</i>	<i>perception</i>	D
Torren	m	1967	M	<i>perception</i>	D
Blake	f	1969	M	<i>perception</i>	D
Charles	m	1969	M	M	<i>perception</i>
Capri	f	1971	<i>perception</i>	<i>perception</i>	D
Dayne	m	1973	<i>perception</i>	<i>perception</i>	D
Joanne	m	1977	<i>perception</i>	<i>perception</i>	D
Helen	f	1978	M	M	<b>production</b>
Deanna	f	1979	M	<i>perception</i>	<i>perception</i>
Dawson	m	1980	<i>perception</i>	<i>perception</i>	<i>perception</i>
Gus	m	1982	D	<i>perception</i>	D
Kelly	f	1986	<i>perception</i>	<i>perception</i>	<i>perception</i>
Cherokee	f	1988	M	M	D
Thane	m	1988	M	<i>perception</i>	<i>perception</i>

method to use—it is entirely possible for an individual to exhibit differences in production that don't show up through testing of formant values, for example. That said, though, there is a danger in going to the opposite extreme. For example, consider a situation where someone merged the vowels in *pull*, *pole*, and *pool* according to tests of formant values but also exhibited an extreme rounding of *pole* but not *pull* or *pool*. The question arises—should a study such as this one consider *pull* and *pool* as being produced differently? Similarly, if they should, at what degree of difference should the cutoff line be? Future work should deal directly with these issues.

Finally, this paper is the latest report to confirm that mergers in perception precede mergers in production in various environments; one could certainly argue that it is a conclusion that is now established. However, this is only one part of the larger issue of matches and mismatches between speech perception and speech production. A vital issue in the perception/production situation is whether this mismatch occurs in situations other than mergers. One has to wonder whether there is a similar perception/production mismatch when phonemic classes split. If the answer is no, then work will have to be done to explain why exactly there is such a difference—but if the answer is yes, linguistics will be a step closer to developing a theory that can account for all types of phonetic change. In addition, finding out whether there is a perception/production mismatch in such spheres as syntactic and lexical change is equally important. Such research would have the effect of helping determine whether all transmission of linguistic change functions in the same way, or whether the human mind really does deal with different classes of linguistic processes in very different ways.

## NOTES

1. It should be noted that this phenomenon was documented earlier than 1972—Labov, Karan, and Miller (1991) report personal communication from David de Camp that the phenomenon was documented but unrecognized in the early 1950s.

2. Also, data collected for the Phonological Atlas of North America shows that mergers in perception precede those mergers in production in about five of every seven cases studied (William Labov p. c. 1998).

3. Waldorf is an unincorporated municipality and therefore has no legally set borders. For this study, the borders of Waldorf as defined by the U.S. Postal Service were used—namely, ZIP codes 20601, 20602, and 20603 (ZIP code 20604 is also assigned to Waldorf, but covers only post office boxes). This definition includes not only Waldorf but also St. Charles, a housing development begun in the late 1960s that has grown large enough that it often appears as a separate (and larger) town on maps.

4. The distance given is road miles, and the population given is the combined population of the unincorporated municipalities of Waldorf and St. Charles.

5. It appears that some speakers may merge the vowels in *dull* and *pull*, as well, but in any event this occurs only sporadically and so is not dealt with in this paper.

6. From the evidence collected, it seems that the process by which the mergers take place begins, crucially, with the fact that the Waldorf /o/ and /u/ are fronted everywhere, including word-internally, *except* pre-laterally. The vowel in *pull* is backed (likely in conjunction with a backing of /ʌ/) and the vowel in *pole* raises until *pull* and *pole* are merged; after this, the vowel pool lowers until it merges with the merged *pull/pole*. A complication can occur in which /o/ and /u/ are actually fronted pre-laterally by some speakers (whether from /l/-vocalization or general fronting is unclear), but this happens only sporadically and doesn't appear to have any real effect on the data presented in this paper.

7. The subjects were told that this step was being taken and why. This was done so that if someone who had memorized the list was taking the test, that person wouldn't get items unnecessarily wrong simply due to being out of phase with the words that were actually being played.

8. This is a very strict standard—even just one misidentified word resulted in the subject being labeled as having a merger in production. The rationale, however, is that if there is a robust distinction between two

phonemes (as an example, consider the initial consonants in *mat* and *cat*), there would be absolutely no confusion between them (Sherry Ash p. c. 1998).

9. Using WinSAL version 1.2a, a computer program produced by Media Enterprise.

10. The older group merges the sounds 78.57% of the time versus 93.33% for the younger group, verified as significant by a chi-square test to a level of  $p < 0.0001$ .

11. With the older group merging the sounds 58.33% of the time and the younger group 94.12% of the time, verified by a chi-square test to a level of  $p < 0.001$ .

12. The older group merges the sounds 13.04% of the time and the younger group 66.67% of the time, which chi-square testing shows to be significant to a level of  $p < 0.001$ .

13. This is not just an artifact of the method used to determine merger in production—an analysis that assumes that *any* overlap of vowel spaces constitutes merger in production also results in the finding that merger in production is more widespread than merger in perception (Bowie 1998).

14. 12.50% merged by the older group and 53.85% in the younger group, with a chi-square test showing this split significant to a level of  $p < 0.01$ .

15. The older group merges these 5.88% of the time, the younger group 25.00% of the time; chi-square testing declares this significant to a level of  $p < 0.0001$ .

16. The two exceptions to this: Theona perceives and produces *pull* and *pool* as merged, but several speakers born in the forty years following her birth perceive and produce those words as separate. Also, both Elise and Jeri (born 1946 and 1951, respectively) merge *pull* and *pole* in both perception and production, but Rosa and Gus (born 1963 and 1982) maintain a complete distinction. Because these exceptions are so uncommon, however, they are left to the side for the current analysis.

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