ESRC Research Proposal

The acquisition of Standard British English rhotics: production and perception data

Rachael-Anne Knight
Mark J. Jones

Introduction

It is well known that Standard Southern British (SSB) /r/ is highly variable across speakers and contexts. /r/ has an interesting history and it currently seems that a new realisation is spreading among younger speakers. However, there is much that we do not know about /r/, specifically in terms of its developmental path in SSB. For example, it is not known precisely which variants are used before adult-like /r/ is mastered, and what the link is between production and perception. The present study aims to answer some of these questions by examining the development of /r/ in British English children between 36 and 48 months old.

Background

Articulatory variants of /r/ in English

For most speakers of Standard British English /r/ is realized as an apical postalveolar approximant, though the precise articulation of /r/ can take a number of forms. For example Westbury et al. (1998) describe a continuum of variants ranging from articulations with a bunched tongue dorsum to those with a retroflexed tongue tip. Furthermore, it has recently become apparent that many younger speakers in England now use an entirely different variant of /r/, which seems to not only lie outside of this articulatory continuum, but also is not among the class of sounds usually described as rhotic (Docherty and Foulkes, 2001). This variant has been described in the literature as a labial or, more commonly, labiodental approximant. As Foulkes and Docherty (2001) state, many earlier descriptions class this variant as a speech defect (e.g. Gimson, 1980), or as a feature of either immature speech (e.g. Gimson 1980) or upper-class speech (Wells, 1982). More recently, however, the labiodental realisation is becoming increasingly common in varieties across England. For example, Trudgill's (1974) work in Norwich shows that in 1974 there were very few instances of the labiodental variant, but in Trudgill (1988) it is reported that by 1983, 33% of speakers born between 1959 and 1973 use it. In addition Foulkes and Docherty (2001) found that some speakers from both Newcastle and Derby used the variant although its use was confined to younger speakers.

At this point in time it is still unclear why the labiodental variant is spreading, Kerswill (1996) suggests that there is no link between the variety used by a child and their primary caregiver, and although factors such as the mass-media have been suggested (Foulkes and Docherty, 2001), no study has established a firm link. It is clear, however, that any variable can spread once it has acquired a particular sociolinguistic status. In the proposed study, the question of why the labiodental realisation should exist for any speaker is addressed. The focus is on the actuation of sound change, that is, the

relationship between adult-like apical /r/ and infantile labiodental /r/, rather than transmission of the change through the community. More work on production, perception and acquisition is required if this question is to be answered.

The acoustics of English /r/

Despite the variety of articulations which may be used to produce an approximant /r/, the acoustic properties are largely consistent across the articulatory continuum. The most striking acoustic feature for /r/ is a low third formant (F3) which is close to the frequency of the second formant (F2) (e.g. Guenther et al., 1999). The low F3 is found for both bunched and retroflex articulations, and this appears to be the target of speech production, rather than the use of a particular articulation. The *labiodental* approximant, however, does not have a low F3 (Docherty and Foulkes, 2001), and yet seems to function as /r/ for the speakers who use this variant. However, despite this lack of a low F3, Jones (2004) demonstrates that there *is* a principled acoustic relationship between apical and labiodental realisations of /r/. Speakers who use a labiodental realisation produce an F2 which occurs at a frequency between that of F2 and F3 at the consonant midpoint of apical /r/. It is possible that the F2 of labiodental /r/ represents a spectrally integrated resonance of apical /r/ F2+F3 (Chistovich 1985). This finding further suggests that speakers who use a labiodental variant are doing so in a principled fashion based on how the two variants sound, and are not just making a best articulatory attempt at an apical /r/. This calls into question the view that labiodental realisations are defective, and suggests a developmental stage for children at which some phonetic details of the acoustic signal are ignored, but more work is needed to establish the acoustic properties of the variant in additional speakers, structural contexts, and in connected speech.

The acquisition of /r/

Research into phonological acquisition suggests that adult-like /r/ does not emerge until around the age of 4;5 (after most other sounds) and remains highly variable before being mastered at around 6;0 (e.g. Vihman, 1996:219-239). There has been relatively little research focussed exclusively on the acquisition of /r/ and much of that which has been conducted is of limited use. A good deal of the research is rather old, and, crucially has considered only American children. This is problematic for a number of reasons. Firstly, the articulation of /r/ may be different in American and British English. For example, there is evidence that American speakers may also use a pharyngeal gesture (Gick 2002). Secondly the phonotactics of the two varieties are different. Most accents of British English are non-rhotic and /r/ can only occur syllable initially. Most American accents, by contrast, are rhotic and allow /r/ to occur in both syllable initial and syllable final position. There is also evidence that the syllable final /r/ occurs earlier in development (possibly due to its lack of a pharyngeal constriction (McGowan et al, 2004)).

An additional problem is that studies which have looked at children's acquisition of /r/ commonly class any mispronunciations as [w]-like. Some children may indeed substitute [w] for /r/ but it is also likely that these children are really substituting a labiodental (rather than a labial-velar) approximant. This complicates comparisons across studies and it is clear that a more thorough analysis of British subjects is needed.

It is also interesting to note that a labiodental approximant is a common point on the developmental pathway towards apical /r/ (Shriberg and Kent, 1982, Kerswill, 1996).

Jones and Knight (2005) have hypothesized that speakers who retain labiodental /r/ into adulthood may do so because, for those speakers, the immature variant and the adult variant are sufficiently equivalent in an auditory sense that the adult variant need not be acquired. This hypothesis needs to be tested empirically using perceptual experiments, and longitudinally by examining the development of /r/ over time in young children to test whether children's change in production correlates with a change in perception.

The relationship between production and perception of /r/

In general the relationship between production and perception is a complex and interesting one. For example, many researchers aim to test the hypothesis that listeners refer to their own articulation when perceiving speech, or, conversely, that speakers' productions will be defined by their perceptual abilities. These studies generally use the same subjects for both a production experiment, and for perceptual identification or discrimination of synthetic speech sounds. Conflicting findings have emerged. For example, for glides, Ainsworth and Paliwal (1984) found no evidence that adults who produce a contrast more precisely also perceive it more acutely. However, for vowels, Perkell et al (2004) found that adults who were better at discriminating between synthetic vowels also produced a greater articulatory difference between those vowels.

There is also some disagreement in the literature about the perceptual abilities of children who mispronounce /r/. Menyuk and Anderson (1969) for example, indicate that even if a child can identify that a word begins with /r/, rather than with /w/ or /l/, the child's own reproduction of that word may sound to adults as though it begins with a /w/. This result indicates that children may be able to perceive phonemic contrasts before they are able to produce them in an adult like way. This is similar to findings for other contrasts, and follows the general pattern that production lags behind perception in development, for example when learning vocabulary. Strange and Broen (1980), on the other hand, using better quality synthetic stimuli, found that the relationship between production and perception for the /r/ contrast was more complicated. Children who were classified as having good production of /r/, /w/ and /l/ were found to perceive these differences consistently. However, for children with difficulties in production, perception was adversely affected and they were more variable in their classification of intermediate stimuli. This indicates that a difficulty in production can be linked to a difficulty in perception, although it should be noted that all the children performed above chance level, and some performed at close to ceiling level.

In a pilot study Jones and Knight (2005) tested the perceptual abilities of *adults* who use a labiodental realisation of /r/. The experiment aimed to test whether adults who use a labiodental approximant (and therefore possibly have a fossilized, immature variant) view labiodental and apical realisations as perceptually equivalent. A 'same-different' experiment used 10 adult speakers as subjects. Five subjects who use an apical realisation and five who use a labiodental variant of /r/ listened to pairs of vowel-consonant-vowel stimuli. They pressed a button to indicate whether the consonants in the two members of the pair were the same or different. Consonants included apical /r/s (labialized and unlabialized), labiodental /r/s (plain and velarized) and the labial-velar approximant. Speakers who use a labiodental variant had greater difficulties than speakers who use an apical variant in discriminating between these different sounds.

This goes someway toward supporting the view that users with labiodental /r/ have fossilized an immature variant on the basis of the perceptual equivalence of the immature and adult variants. However, much more research is needed. Specifically, it is important to develop perceptual tests where formant values are precisely manipulated to create stimuli with formant values intermediate between the different variants. This will allow the relationship between the production and perception of /r/ to be assessed more accurately in both adults and children.

The proposed project

The proposed project aims to investigate the acoustic properties of /r/ sounds during their acquisition and to design a set of stimuli for testing perceptual abilities of children in relation to different /r/ sounds. It is proposed that children's productions of /r/ and their performance on purposely designed perceptual tests are recorded at three points during the study, about 3 months apart. It is also proposed that adults are given perceptual tests using specifically designed stimuli. This work will gather useful data on the acoustics of /r/ in young British children, and will also begin to address the question of why labiodental /r/ users maintain a realisation of /r/ which differs from the majority of /r/ tokens in their environment. In addition, the project will investigate the wider issue of the link between production and perception in adults and children.

The Gannt diagram below shows the stages of the project and their respective timings

Objective	J	A	S	O	N	D	J	F	M	A	M	J
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Objectives:

1. Finalizing and piloting of production and perception tests
2. Adult testing with resynthesized stimuli
3. Results for adult testing
4. Child Testing phase 1
5. Results for child testing phase 1
6. Child testing phase 2
7. Results of child testing phase 2
8. Child testing phase 3
9. Results of child testing phase 3
10. Write up and dissemination

Research Questions

The main research questions underlying the work are as follows:

1. What are the acoustic properties of /r/ in different structural contexts for British English children aged between 36 and 48 months of age?
2. What is the variability (between children and contexts) in the acoustic characteristics of /r/ for children between 36 and 48 months of age?
3. What, if any, are the differences in perceptual abilities between children with a labiodental, and children with an apical realisation of /r/, and how do those abilities change over the course of acquisition?
4. How do the perceptual abilities of children compare to those of adults in relation to /r/ like stimuli?

Datasets review

A review of the UKDA datasets does not reveal any relevant datasets. This is because children must be tested with the same perceptual test as previously used on adults and those same children must be recorded for the acoustic analysis.

Data collection

Data Collection will take place mainly in nurseries at three points during the study. At each collection point the following data will be gathered:

1. Articulatory assessment

The Diagnostic Evaluation of Articulation and Phonology (DEAP) (Dodd et al., 2002) assessment will be carried out with all children in order to obtain a measure of their articulatory and oral abilities.

2. Recordings of /r/

A task will be designed to elicit tokens of /r/ in different contexts (for example, before different vowels, in initial clusters, word medially). This will take the form of a picture naming game. Children's responses will be recorded onto Marantz recorder for subsequent acoustic analysis. These recordings will be made available as a database lodged with the ESDS.

3. Perceptual tests

All the children will take part in perceptual tests in which they will be asked to listen to tokens of various /r/-like sounds in an XAB format. In addition a number of adult subjects, recruited from City and Cambridge Universities will take part in the same perceptual tests as the children.

Potential Problems

Children will be selected from classrooms in mainstream nurseries and their parents will be asked to consent to their participation. It is possible that too few parents will consent, but we will do our best to avoid this by sending a letter with the consent forms explaining the nature and purpose of the experiments. This letter will emphasize that the tests will consist of fun games, and describe what the potential outcomes might be. It is also possible that children will change schools, or for other reasons not be available at all three testing times. In anticipation of this problem we will initially test 40 children, although our research is viable with half this number. It may be difficult to find a quiet place to conduct recordings but we will discuss this with nursery staff beforehand and hope to gain access to a staff-room or empty office. We will also aim to disrupt classes as little as possible by testing children from three different establishments. We must also ensure that the research assistant passes a police check before they work with children. This will be clearly stated in the advertisement for the post, and the assistant will not be permitted to enter the school until the checks are complete. There are no outstanding ethical issues, but the project will comply with City University's ethical guidelines.

Framework and methods for analysis

Summary

Forty children from three different nurseries in the South East of England will be tested at three points between the ages of 36 and 48 months (when adult-like /r/ should not yet have been mastered). The testing will involve an assessment of articulation and phonology, a specially designed test to elicit tokens of /r/, and various perceptual tests.

Production

The DEAP assessment will be analysed in the standard way in order to obtain a gross measure of articulation and oral motor control from each child at each testing time. This will allow the results of the other assessments to be related to these general skills.

The part of the study concerned with the production of /r/ will involve children naming pictures where an /r/ would occur in adult production (as well as fillers not containing /r/) in a picture matching game. The /r/s will occur in many different contexts such as word initially, word medially, and in clusters. Children will be engaged by the use of colourful pictures and by the enthusiasm of the experimenter. A system will also be used whereby the child is rewarded with a small prize (such as a sticker) after completing each section of the task at hand. The word game will be recorded with a Marantz recorder and the words containing /r/ will be extracted for analysis with a package such as PRAAT. From each token the measures taken will be the values of F2 and F3 (and possibly higher formants if these are measurable) as well as other data such as the duration of /r/. Each token will be classified as either apical or labiodental /r/ by reference to the auditory quality and acoustic data (although following Foulkes and Docherty (2001) it may be necessary to class tokens according to a four point scale rather than dividing them into two discrete categories). As these data will be taken at three points during the study we will gain an insight into the developmental progression for each child and whether there is any difference in the acquisition of /r/ when it occurs in different phonetic contexts.

Perception
The perception studies will be of two types. The first is the perception of natural /r/ like tokens which have already been piloted with adults. In this experiment it is hypothesized that children who have not yet acquired an apical approximant will make more errors than children who have acquired the apical variant. The second type of perception tests will involve tokens created by formant synthesis where F2 and F3 are precisely manipulated. It is hypothesized that children will be more likely to classify tokens as /r/ if the formant values are close to those in their own productions of /r/. These stimuli will be created during the grant and will be piloted with both adults and children in the first stage of the project. The stimuli for both sets of perceptual tests will mainly be presented in an XAB format where the subject must match a sample to one of two given tokens. The user-interface will be SiPC (developed at UCL, http://www.ucl.ac.uk/~sslymag/Listening/sipc.html) which creates a visually interesting environment for the child and rewards them with additional visual information after each response so that they are rewarded for responding rather than for giving a correct answer. The stimuli will be presented in a number of short sessions to avoid fatigue. All statistical analysis will be carried out in SPSS using ANOVA, MANOVA, linear regression, correlation coefficients and other relevant techniques.

Forty adults (20 with apical and 20 with labiodental realisations of /r/) will also be asked to take part in the perceptual tests so that their results can be compared to those of the child participants.

Outputs
The project will generate the following outputs:

- Conference presentations e.g. International Congress of Phonetic Sciences (occurring every four years) and Linguistic Association of Great Britain (annual).
- Journal articles e.g. Journal of the Acoustical Society of America, Journal of Speech and Hearing Research.
- Project website(based at City university), containing information about the project and regular progress reports
- a seminar at the end of the funded project, to be hosted at City University, in order to discuss the project and results with the wider academic, and clinical, community
- a database of the recordings of /r/ lodged with the ESDS

Justification of expenditure

Directly Incurred
<u>Staff</u>
The research assistant will collect all the data from the participants in the project. The RA will also take part in the creation of the formant-synthesized stimuli, data analysis after each stage of collection, and dissemination. Therefore the research assistant needs to work on the project full-time. It will be necessary to employ a research assistant who

already has a PhD, and some experience in data collection from children and/or acoustic analysis. For this reason the RA will be employed at spine point 7.

Travel and Subsistence

The Linguistics Association of Great Britain holds an annual colloquium which is the main forum for the presentation of British research in linguistics. The RA and either Knight or Jones will attend to present results relating to the developmental pathway and production-perception link for rhotics. Subsistence costs include estimates for hotels and meals during the conference, and travel and conference fees are also requested.

The International Congress of Phonetic Sciences is a major international phonetics conference held once every four years. It is considered to be the pre-eminent forum for the presentation and discussion of phonetic research. The conference includes relevant streams on sociophonetics, and perception and production. The RA and either Knight or Jones will attend to present results relating to the developmental pathway and the production-perception link for rhotics. Subsistence costs include estimates for hotels and meals during the conference, and travel and conference fees are also requested.

An essential part of the proposal is the testing of children in schools in the South East area. The testing will take place in three intensive sessions covering six months of the grant and travel will also take place to meetings at the nurseries. The money requested in the grant will allow the RA to travel for these purposes.

Travel for project meetings is also applied for so that progress can be monitored on a monthly basis.

Equipment / Consumables/Other costs

A laptop is required so that the research assistant can present the computer based perception tests to the children in nurseries. This laptop will also be used for some of the acoustic and statistical analysis, and some of the write-up and dissemination, and therefore Microsoft Office is required. High-quality headphones are necessary to listen to the recordings and synthesized stimuli.

A number of items are required for recording the children's productions of /r/. An omnidirectional microphone and preamplifier will be used to record the data to a Marantz portable recorder. The Marantz recorder requires flash memory cards so that data can be stored. CDs are required to back-up the data, and to archive the material for ESDS.

The DEAP test is an essential part of the planned data collection. This test is already available at City University, but, as the test will be used so frequently, it is essential that a dedicated version is available to the project so as to not remove resources from the clinic and students.

Stationary and consumables include items such as pens, pencils and paper for printing. It also includes the reward stickers that will be given as motivational prizes to the child participants.

The seminar at City at the end of the project will report to academics and clinicians on the results of the research. Money is requested for publicity, room bookings and catering.

Subject payments are requested for the adult participants. We will test 40 adults and will pay them £5 each.

Directly Allocated
Rachael-Anne Knight has experience in conducting production and perception experiments gained both before, during and since her PhD at the University of Cambridge. She will be responsible for overseeing the project, supervising the research assistant, managing the creation of stimuli, and the acoustic and statistical analyses. It is estimated that this will take 5 hours per week. Other commitments include approximately 8 hours per week of teaching, 8 hours of teaching preparation, 8 hours of administrative duties and 8 hours of other research activities.

Mark Jones is very experienced in acoustic analysis of speech, and has also conducted pilot research into the production of labiodental /r/. He will mostly be involved in the acoustic analysis and subsequent interpretation of the results. He will also consult on any problems in data collection and analysis. It is estimated that this will take on average 2 hours per week. Other commitments include 2-3 hours of teaching per week with the remaining hours being spent on a British Academy Postdoctoral Fellowship.

Please see Appendix 1 for bibliographic details.
Word Count = 3,982.