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You're not from around here, are you? -

A dialect discrimination experiment with speakers of British and Indian English[1]

Robert Fuchs

Englisches Seminar, Westfälische Wilhelms-Universität Münster

1. Introduction

Speakers of a language often have implicit knowledge of other dialects of their language. Such knowledge allows them to categorise strangers into those hailing from the same region, and those who do not. Considering the role of language as a strong marker of identity, it is possible that speakers have access to a wealth of knowledge when it comes to dialect identification.

1.1 Dialect discrimination

While the role of different phonetic cues (such as intonation and speech rhythm) has been documented for language discrimination by adults and infants, among others (see Vicenik 2011:1-50 for an overview), less is known about what cues are important or take precedence when it comes to distinguishing dialects of a single language.[2] Using low-pass filtered stimuli, Vicenik (2011) showed that speakers of American English (AmE) can discriminate their dialect from Australian English (AusE) using intonation and rhythm, but not rhythm only. When AusE stimuli were resynthesised with AmE intonation and vice versa, intonation was used as a relevant cue, but discrimination rates were lower than expected. This led to the conclusion that other acoustic cues, such as differences in the realisation of certain segments, must be an important acoustic cue. Jilka (2000a,b) also

1 The author would like to thank all speakers and participants for taking part in the study, Marije van Hattum, Tiasa Almendra and Chandrasekar Kandharaja for help with conducting the listening experiments, and Olga Maxwell, Ulrike Gut, Adrian Leeman, the reviewers and the editors for comments on an earlier version of this article.

2 In the following, only studies involving varieties of English will be referred to. For similar work on other languages, see, for example, Boula de Mareüil and Vieru-Dimulescu (2006).

found segmental differences to be a stronger cue to foreign accent in German learners of English than intonation.

Intonation was also shown to be a source of information in language discrimination in earlier work by de Pijper (1983), where adults heard stimuli resynthesised on the basis of English recordings but with English or Dutch intonation. Bush (1967) presented Indian English (IndE), British English (BrE) and AmE stimuli to participants speaking either of these dialects. Segmental differences were shown to be an important, but not the only cue to dialect discrimination. The role of rhythm was demonstrated by Szakay (2006, 2007, 2008), who showed that New Zealanders can discriminate different varieties of New Zealand English based on only differences in speech rhythm.

In summary, previous research has shown that segmental differences, differences in intonation and differences in rhythm can be acoustic cues in dialect discrimination. However, it is not known whether any of these cues is more important than the others. Previous research on IndE (Bush 1967) has shown that in the 1960s speakers of this variety were able to discriminate their dialect from other varieties of English. However, it is not clear whether this state of affairs is still current almost 50 years later. Also, it is unclear whether rhythm, intonation or segmental differences are more important cues when discriminating IndE and BrE.

1.2 The Sociolinguistics of Indian English

This pilot study seeks to investigate what phonetic cues speakers of educated Indian English (IndE) and British English (BrE) use when distinguishing these two dialects. While BrE is mostly used as a first language, IndE is often acquired in formal contexts such as schools and used for specific purposes (education, administration, economy, pan-Indian communication, among others) in a multilingual environment (see Sailaja 2012 for an overview). Educated IndE and BrE differ from each other in a number of syntactic and pragmatic features, such as the use of determiners (Davydova 2012, Sedlatschek 2009, Sharma 2005), verb complementation, the extension of the progressive (Collins 2008, Davydova 2012, Sharma 2009) and lexical focus marking (Fuchs 2012b, Lange 2007, 2012, Parviainen 2012, Sedlatschek 2009)

It is conceivable that speakers of IndE have basic knowledge of the pronunciation of BrE and the other way around. Decades of immigration from the subcontinent to the UK have made hearing IndE in the cities of the United Kingdom common. Educated speakers of IndE, on the other hand, appear to have a very ambivalent relationship with BrE. Whether or not speakers of IndE are able to discriminate BrE from IndE on acoustic grounds therefore has sociolinguistic implications.

Such an ambivalent relationship with the mother dialect is to be expected, as IndE currently finds itself at stage three or four of Schneider's (2003, 2007) Dynamic Model of Post-colonial Varieties of English. Schneider's model describes the development of post-colonial varieties of English in five stages, beginning with the first contact with traders or settlers (foundation stage/stage one), followed by a strong linguistic orientation to the mother dialect (exonormative stabilisation/stage two), and from which a new dialect arises through contact between the colonised and colonial population. Stage three, nativisation, witnesses many innovations in the new dialect, with in stage four, endo-normative stabilisation, slowly become accepted, eventually leading to stage five, differentiation. IndE has currently reached stage three (Schneider 2007: 161-73) or four (Mukherjee 2007), both of which are characterised by a high degree of linguistic insecurity. This insecurity if caused by the tension between old (usually BrE) "exo-normative" orientations and new "endo-normative" orientations. A common symptom is the so-called complaint culture, fuelled by cultural stalwarts defending exo-normative standards. This complaint culture deplores what some perceive as a deviation from the norms of the mother dialect (BrE in the case of India).

However, there also appears to be a trend in the opposite direction, with the young Indian elite feeling quite strongly about the emerging standards. In sociolinguistic interviews, conducted by the present author in February and March 2012 in Hyderabad, India, 35 speakers were asked the following questions, among others: Whether they preferred hearing a certain accent, and how they would react towards an Indian (who grew up in India) using a British or American accent. Answers to these questions were almost unanimous. In terms of preferences for a certain accent, the main requirement that informants gave was that whatever accent a speaker may use, it should be intelligible. This indicates a great tolerance towards accents other than their own. This professed tolerance, however, is only half of the story, and in the course of the interviews it often became clear that informants were often referring to what degree they find mother tongue influence tolerable with speakers of IndE ("Mother tongue influence is not a problem, but their accent should be intelligible."). Answers to the second question, however, showed intolerance towards Indians using British or American accents. Such accents were called "fake" by many informants, and there was a general conviction that no matter how hard an Indian speaker of English might try, their approximation of a British or American accent would remain imperfect: "They speak with their polished British/American accent, but at some point their Bangla/Telugu/Hindi etc. accent resurfaces" (exceptions were made for persons of Indian origin that grew up in the United Kingdom or United States). Such conclusions are supported by Sridhar (1996) and Sonntag's (2011) comments that Indians with a British accent are often perceived as "phony" or "stand-offish" by other speakers of IndE.

These results allow the following conclusions: Speakers of educated IndE think they are well aware of differences between the pronunciation of BrE and IndE. Despite a professed tolerance towards accents different from their own ("only intelligibility counts"), when members of their own community start deviating from an Indian accent and use a British or American accent, most IndE speakers find this unacceptable.

Such strong feelings about maintaining an IndE accent seemingly presuppose an excellent ability to distinguish Indian and British/American accents on the part of those who reject British and American accents (at least when used by Indians). However, when it comes to maintaining one's own identity in the face of a perceived threat from "others", familiarity with the "other" actually seems to be unnecessary if not detrimental to the ability to reject the "other". In fact, decades of research on the "contact hypothesis" have shown that familiarity with the stereotyped group reduces prejudice (see Pettigrew and Tropp 2005). Another relevant point is that American and British films and series (but not Indian actors speaking English) are usually subtitled on Indian television, which suggests that at least a sizeable proportion of the audience is unfamiliar with these accents.

1.3 Differences between the phonologies of Indian and British English

It is therefore not a foregone conclusion that educated speakers of IndE are actually able to distinguish Indian from British accents, and if so, what this ability rests on. Potential acoustic cues include a number of segmental and suprasegmental differences between IndE and BrE that have been reported in the literature. Major segmental differences are the /v/-/w/ merger (*will* and *village* are pronounced with the same phoneme in initial position), th-stopping (pronunciation of *thin* as [t^{h}ɪn]), and a lack of aspiration in voiceless plosives in IndE (pronunciation of *tin* as [tɪn], not [t^{h}ɪn] as in BrE; see Fuchs 2014 and Sailaja 2012 for an overview). Moreover, in IndE, the contrast between lax and tense vowels (such as *pull* vs. *pool*) is not always maintained (e.g. Masica 1972, Gargesh 2004). In addition to impressionistic accounts, there is instrumental evidence of the monophthongisation of the GOAT diphthong to [o] and the FACE diphthong to [e] (i.e. *goat* pronounced as [got] and *face* as [fes]; Maxwell and Fletcher 2010a). The rhythm of acrolectal (i.e. educated) speakers has been shown to be more syllable-timed compared to BrE (Fuchs 2012a, 2014). Meso- and basilectal speakers (i.e. those with less or little formal education) might have an even more syllable-timed rhythm. There is also some evidence of considerable differences in intonation between IndE and BrE. These concern the identity of tones (preference for rising pitch accents such as H*L and H*; Maxwell and Fletcher 2010b), the higher frequency of accented syllables (many content words are accented, Wiltshire and Harnsberger

2006, Maxwell and Fletcher 2010b) as well as pitch range (wider than in BrE) and mean pitch (higher than in BrE, Fuchs 2014b).

1.4 Aims of this study

Given these segmental and prosodic differences between IndE and BrE, it seems possible that speakers of both varieties might be able to distinguish both accents based on acoustic information. As argued above, many speakers of educated IndE have an ambivalent relationship with BrE, which is likely due to the current stage of IndE in its development as a post-colonial variety of English. This ambivalence towards BrE, as well as that variety's considerable word-wide prestige, would suggest that IndE speakers have accurate knowledge about the phonetic and phonological differences between IndE and BrE. This suggests the hypothesis that speakers of IndE can distinguish it from BrE (see Table 1). If they can do so, the next question to ask is which distinctive features of the phonology of IndE and BrE, segmental characteristics, intonation or rhythm, are used by listeners to discriminate the two dialects. However, the ambivalence towards BrE might also be based on a partly or wholly distorted image of the pronunciation of BrE. This, in turn, suggests that speakers of IndE cannot distinguish it from BrE.

	Hypothesis	Follow-up research question
H1	IndE listeners can distinguish IndE from BrE	If yes, which cues (segmental differences, intonation, rhythm) do they rely on? Do IndE and BrE listeners rely on the same cues?
H0	IndE listeners cannot distinguish IndE from BrE	

Table 1. Hypotheses for the present study.

2. Data and Methods

In order to answer these questions, a dialect discrimination experiment was conducted. The following sections explain the experimental design (2.1), the selection of participants (2.2), the recording and resynthesis of the stimuli (2.3), and the analysis of the experimental data (2.4).

2.1 Experimental Design

The study was computer-based, using the MFC experiment environment provided by Praat (Boersa and Weenink 2012), and sound stimuli were presented over headphones in a quiet room. Participants heard 112 versions (in random or-

der) of the sentence “The mouse said: 'Please tiger, let me have it. You don't even like cheese. Be kind, and find something else to eat.'”, which is the second sentence of a short story entitled “A Tiger and a Mouse”. After listening to each stimulus, participants were asked to “choose whether the speaker is British or Indian”. A choice was forced between “Indian”, “somewhat Indian”, “somewhat British” and “British”. Participants could replay the current stimulus as often as they liked, but were not allowed to alter previous judgements. After every 40 stimuli, participants were offered a short break. The whole experiment took between 15 and 20 minutes, on average.

2.2 Participants

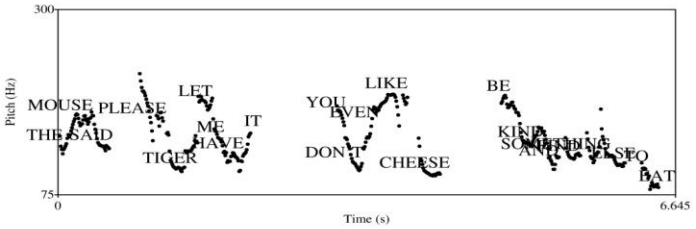
In total, 34 participants took the experiment. 17 of these were speakers of IndE and 17 were speakers of BrE. All participants were university students at the time of the study (2012), except one Indian participant who was a university lecturer. All were born and raised in India and the United Kingdom, respectively. The Indian participants were proficient speakers of English, and English was the medium of instruction for their university studies as well as, for most of the participants, in their schooling. Hence, they can classified as educated or acrocectal speakers. 9 of the Indian participants gave Bengali as language of highest proficiency other than English, 3 Malayalam, 2 Tamil, 1 Telugu and 1 Hindi.

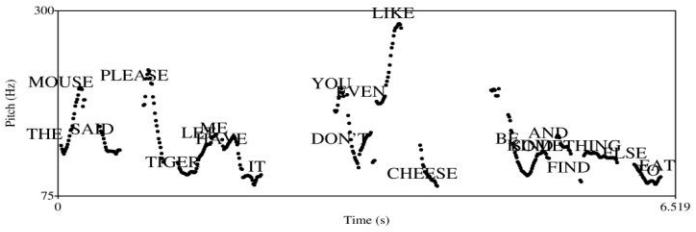
The British participants were taking part in a class on World Englishes, but received no course credit for their participation in the experiment, which was in all cases voluntary and unpaid, and took place on university premises. The Indian participants took the experiments on university premises in Hyderabad, India, except for one participant, who took the experiment during an international conference. Of the Indian participants, 9 were female and 7 male, and of the British participants 15 were female and 1 male. 1 participant from each group declined to specify their sex. Median age of the British participants was 21 (range 20-23, 1 declined information), and of the Indian participants 23 (range 20-33, 2 declined information).

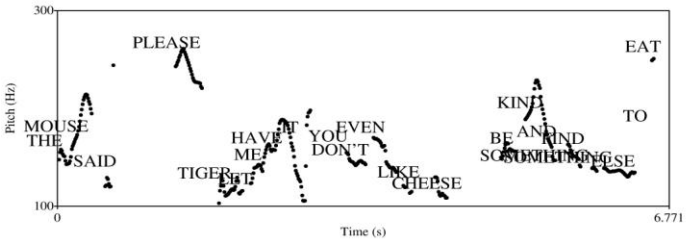
2.3 Stimuli

As the character of this study is exploratory, it was decided that the focus should lie on including as many different combinations of segmental and suprasegmental features as possible. As a trade-off, the stimuli were based on the minimum number of speakers necessary (two per variety) and speaker sex was kept constant. A total of 112 unique stimuli was presented to participants in random order. 4 of them were original recordings, 2 read by 2 male BrE speakers (taken from the LeaP corpus, Milde & Gut 2002, Gut 2012), and 2 read by 2 male

IndE speakers (recordings made by the author). The IndE speakers were enrolled in a degree programme in English language and linguistics in Hyderabad (India) at the time of recording, had always resided in India and spoke Hindi and Malayalam, respectively, as first languages. The remaining 108 stimuli were resynthesised using Praat's PSOLA algorithm, prior to the experiment.







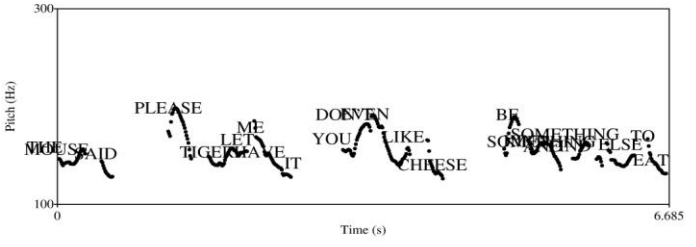


Fig. 1. Pitch contours of both BrE speakers (top) and both IndE speakers bottom). Vocalic and consonantal durations of the second speaker of each group were aligned with the first speakers.

The differences between how the four speakers read the sentence are in many respects representative of differences between educated IndE and BrE. First, the GOAT vowel in *don't* was more diphthongised in the British (12 and 14 % difference in F2 between the first quarter and the third quarter of the vowel) than in the Indian recordings (7 and 8 % difference in F2), and the direction of movement was towards the back of the mouth in the British, but towards the centre in the Indian recordings. This means that the British speakers were producing an [əʊ] diphthong, and the Indian speakers what might be analysed as a monophthong with centralising offset [oə]. Second, aspiration in the initial plosives of *tiger* and *kind* (measured from the start of the burst to the onset of voicing) was an average of 2.4 and 1.6 times longer, respectively, in the British recordings. Third, speech rhythm as measured with the vocalic metrics nPVI-V and VarcoV (see Wiget et al. 2010 for an overview and reliability tests) was more syllable-timed in the Indian recordings (an average of 17 and 20 %, respectively). Only differences observed in mean pitch and pitch range (measured as mean, and standard deviation divided by the mean, of all pitch points in the recordings) did not reflect previous research on differences between IndE and BrE. Mean pitch was particularly high for the first and low for the second Indian speaker, with the two British speakers in between. This means that only one of the Indian speakers conformed to the trend of higher mean pitch in IndE, perhaps because the sentence chosen for the study involved direct speech ("The mouse said"), which might be realised differently in the two dialects. Pitch range was, on average, narrower for the Indian speakers, with only one Indian speaker using a slightly wider pitch range than one British speaker.

However, a closer look at the pitch contours of the four speakers shows that even in the absence of extensive research on the phonology of IndE, characteristics can be noted that might help distinguish the pitch contours used by the British speakers from those of the Indian speakers. The left panel of Fig. 1 shows the pitch contours of the two British speakers and the right panel those of the Indian speakers, which were time-normalised (by setting the duration of all segments produced by speaker 1 to those of speaker 2) to allow a comparison of the of the pitch contours. The BrE pitch contours are relatively similar, while the IndE pitch contours differ from each other in where the major pitch accents are placed. One aspect that sets the Indian contours apart, though, is the occurrence of smaller peaks and troughs, some of which are also integrated into the major peaks. There are thus some similarities in the Indian, and some in the British pitch contours, respectively, that might allow listeners to recognise which speaker belongs to which group.

As one of the aims of the study was to test how much speech rhythm, intonation, and segmental differences contribute to the perceived difference between the two accents, the resynthesised stimuli either suppressed one of these sources of information, or transferred it from another speaker. Suppression was achieved in the following way: To suppress segmental information, recordings were low-pass filtered (0 to 400 Hz pass Hann band, 100 Hz smoothing). To suppress intonation as a cue, the pitch contour was replaced with a flat slope steadily declining from 190 to 110 Hz.[3] Finally, rhythmic information was suppressed by first segmenting recordings into vocalic and consonantal intervals (i.e. stretches of vowels uninterrupted by consonants and vice versa), and then setting the durations of all consonantal intervals to 145 ms and those of all vocalic intervals to 60 ms. However, to avoid artefacts during resynthesis, durations were not shortened more than by a factor of 2 and not lengthened more than by a factor of 5. Switching rhythm and intonation between speakers was also achieved on the basis of segmentation into vocalic and consonantal intervals. To replace the rhythm of speaker A with that of speaker B, the durations of A's vocalic and consonantal intervals were replaced with B's.

3 A reviewer points out that such a pitch contour is unlike the intonation of BrE or IndE. This choice is intentional because the aim of the this type of resynthesis was to remove intonation as an acoustic cue for dialect discrimination. Previous research (such as Ramus and Mehler 1999) used a completely flat contour. However, this differs from most human languages, which often have a declining pitch contour in declarative sentences. Hence, in the present experiment a flat declining pitch contour was used to suppress intonation as a source of information for dialect discrimination.

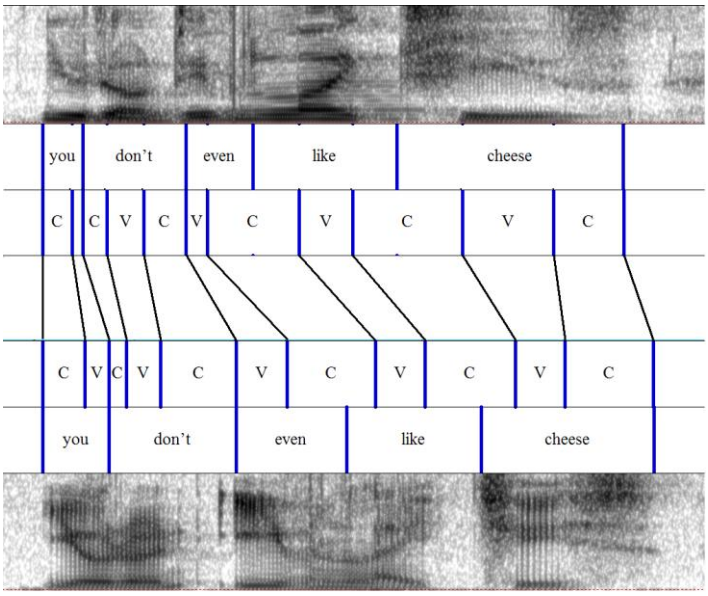


Fig. 2. Time-aligned vocalic ("V") and consonantal ("C") intervals in the sentence "You don't even like cheese", spoken by BrE speaker 1 (top) and IndE speaker 1 (bottom). Slanted lines in the centre show how durations of the intervals in the pronunciation of the two speakers relate to each other.

Fig. 2 shows how this works in practice. For example, the first and third vocalic intervals of the British speaker (top panel) are shorter than the matching intervals in the Indian speaker's pronunciation (bottom panel). When resynthesising the British speaker's recording with the rhythm of the Indian speaker, these vocalic intervals are expanded so that their durations match the durations in the Indian speaker's recording. Conversely, the last vocalic interval in the British recording is longer than the matching interval in the Indian recording. This interval is then shortened when resynthesising the British recording with the Indian speaker's rhythm. The same applies, mutatis mutandis, to all consonantal intervals. This technique was used because in difference to other resynthesis techniques involving rhythm, "sasasa" or "?a?a?a" resynthesis (replacing C intervals with [s] or silence/glottal stops and V intervals with [a], see Ramus and Mehler 1999, Vicenik 2011), it allows the transfer of rhythm from one speaker to another, which is not possible with previously used methods.

	Rhythm	Intonation	Segments	No. of stimuli
1	-	-	-	4

2	-	Transferred	-	12
3	-	-	Low-pass filtered	4
4	-	Transferred	Low-pass filtered	12
5	-	Flat	-	4
6	-	Flat	Low-pass filtered	4
7	Isochronous	-	-	4
8	Isochronous	-	Low-pass filtered	4
9	Isochronous	Flat	-	4
10	Transferred	-	-	12
11	Transferred	-	Low-pass filtered	12
12	Transferred	Flat	-	12
13	Transferred	Transferred	-	12
14	Transferred	Transferred	Low-pass filtered	12

Table 2. Resynthesis conditions of stimuli used in the listening experiment ("-" indicates no manipulation).

An exception had to be made for one of the Indian speakers, who elided one vowel. Consequently, the number of V and C intervals did not match between him and the other speakers. This meant that his speech could be resynthesised with the rhythm used by the other speakers (minus the vowel in question), but not the other way around.

Replacing intonation necessitated a more complex step-wise approach. To replace the pitch contour of speaker A with that of speaker B, tonal alignment had to be preserved, for example a pitch accent on the first syllable of 'walking' in B's pronunciation was imposed on the same syllable in A's manipulated recording. Simply replacing A's pitch contour with B's would have produced temporal misalignment if A spoke more slowly than B or with a different rhythm. To avoid this problem, first A's rhythm had to be replaced with B's, then B's pitch contour was imposed on A's, and then the temporal information (rhythm) of the manipulated sound was again restored to A's rhythm. Only segmental information could not be transferred from one recording to another in such a manner.

These manipulation types, transfer and suppression of certain types of information were also combined. For example, both rhythm and intonation were transferred from one speaker to another to determine the influence of both together, or rhythm was transferred, pitch flatlined and the resulting sound low-pass filtered to

determine what influence rhythm alone had. Since it could not be excluded that the process of resynthesis itself had some influence on the ease of dialect identification, pitch and rhythm were not only transferred from British to Indian recordings and vice versa, but also between Indian and British recordings, respectively. Assume, for example, that the recording of the first BrE speaker was judged to be British by 90 % of participants, a recording of the first BrE speaker with the rhythm of the second was judged to be British 83 % of the time, and a recording of the first BrE speaker with the rhythm of the first IndE speaker was judged to be British 65 % of the time. The influence of speech rhythm on identification as British or Indian would then be 83 – 65 = 18 %. The remaining 7 % difference to the unmanipulated recording of the first BrE speaker would appear to be due to the effect of resynthesis.

Table 2 shows a summary of the conditions included in the main part of the experiment. The total number of stimuli, taking into account all types of manipulations and suppression of certain types of auditory information, amounted to 112. The 4 originals were included to determine whether participants were able to correctly attribute unmanipulated recordings to the two accents. Participants received no instructions other than a short written introduction on-screen, except when they needed reassurance about the low-pass filtered stimuli. Many suspected a malfunction or found it difficult to judge these stimuli. In such cases they were asked to imagine overhearing someone talking next door. Although it is impossible to understand what is being said, they might still be able to guess the speaker's sex and perhaps their accent.

2.4 Analysis of Judgements

The results of the listening experiments were saved in text files and loaded into the R statistical environment. Responses were coded on a numerical scale from '2' ('British') to '-2' ('Indian'), with intermediate values '1' ('somewhat British') and '-1' ('somewhat Indian'). In order to determine which of the fixed factors INTONATION, RHYTHM and segmental information (SEGMENTS), as well as origin of the raters/listeners (RATERS) influenced the judgements, a random effects model was fit to the data with R's nlme library (Pinheiro et al. 2013). PARTICIPANT was specified as a random factor. Table 3 summarises the fixed and random factors of the regression model as well as their levels. Model selection was based on optimising BIC (Bayesian Information Criterion; Akaike 1980) and AICc (corrected Akaike Information Criterion; Akaike 1974). Post-hoc tests were carried out to determine the significance of differences between experimental conditions.[4]

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4 In the following, results of the linear model based on the interval scale rating are reported. Deriving an interval scale from categorical judgements is

After the discussion of the results of the random effects model, individual sections on the influence of single factors will demonstrate and try to corroborate, where possible, the results of the model. It is hoped that this two-pronged approach will suit the needs of readers who prefer a more rigorous statistical analysis (random effects model), as well as those who prefer the more concrete analysis of actual ratings. Combining two approaches also has methodological advantages as one may compensate for shortcomings of the other. However, due to space limitations, only conditions involving the manipulation of one factor at a time (manipulation of either rhythm, intonation or segmental content) will be presented. Other conditions such as the resynthesis of a BrE stimulus with both IndE intonation and rhythm will not be presented in detail in sections 3.3-3.5. However, the linear regression analysis presented in section 3.1 includes all conditions, i.e. also those involving the manipulation of more than one factor at a time.

Factor (independent variable)	Levels
RHYTHM	Indian, British, isoch(ronous)
INTONATION	Indian, British, flat
SEGMENTS	Indian, British, (low-pass) filtered
RATERS	Indian, British
(Random factor: Individual PARTICIPANTS)	

Table 3. Factors and levels included in the linear regression analysis.

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sometimes considered problematic. For a systematic analysis of the data, it appeared useful to refer to how confident raters felt in their judgements (e.g. shift away from "Indian" to "somewhat Indian"), information that would be lost when collapsing judgements to a two level categorical "Indian" vs. "British". For post-hoc tests, the latter approach was used to make sure that significance testing is based on the initial categorical scale. In the end, for the data at hand there were only small differences between a linear model and t-tests were used on interval data compared to a logistic regression and chi-square tests on categorical data. A comparison showed that these methodological choices did not influence the overall interpretation of the data, although small differences remained (such as interactions between factors with smaller coefficients).

3. Results

3.1 Linear Regression

This section presents the results of the mixed effects model (linear regression) that determines the influence of the factors mentioned in Table 3 on the ratings. The mixed effects model takes a number of independent variables or factors, and tries to estimate what influence they have on the dependent variable, or outcome. FACTORS will be printed in small capitals. In the present case, these are INTONATION, RHYTHM, SEGMENTS and RATERS. The levels of these factors will be referred to as Indian, British etc., for example Indian RHYTHM. The levels of the dependent variable (how a stimulus was rated) will be referred to in CAPITALS, for example INDIAN. To give a trivial example, we would expect that a stimulus with Indian INTONATION, Indian RHYTHM and Indian SEGMENTS would be rated INDIAN.

In the mixed effects model, the individual factors INTONATION, RHYTHM and SEGMENTS were significant at $p<0.0001$, and RATERS (rater group) was not significant (but was included because it was involved in interactions). In addition, there were pairwise interactions between

- RATERS and INTONATION,
- RATERS and SEGMENTS (both $p<0.0001$),
- RATERS and RHYTHM (n.s.),
- SEGMENTS and INTONATION, and
- SEGMENTS and RHYTHM (both $p<0.0001$; see Appendix for R code of the model and the results of the ANOVA).

While the significance of factors indicates with how much confidence the results can be generalised to all Indian and British raters, it is also crucial to determine the relative weight of individual factors and their values. Fig. 3 shows the coefficients of all factors and their levels, where the response BRITISH is used as a reference level. All coefficients (also called factor weights) have to be interpreted relative to each other and to the reference level.

- The first line shows that if SEGMENTS is Indian, this has a strong negative influence on ratings, i.e. makes an INDIAN rating much more likely compared to a BRITISH rating (represented here as the zero baseline because it is the reference level).
- When SEGMENTS is filtered (i.e. low-pass filtered, second line) this also has a strong negative influence, which lies between Indian and British

SEGMENTS. Horizontal black lines indicate standard deviations around the values. They do not overlap in the case of SEGMENTS.

- Indian INTONATION made INDIAN judgements somewhat more likely,
- but flat INTONATION had an even stronger influence, i.e. was rated more INDIAN than actual Indian INTONATION (lines five and six).
- Indian RHYTHM, and to an even greater degree isochronous RHYTHM (lines seven and eight), also made classification as INDIAN more likely (compared to British RHYTHM, the zero baseline).

However, the influence of Indian SEGMENTS was three times as strong as that of Indian RHYTHM or INTONATION. Next, Indian RATERS were more likely to rate stimuli as INDIAN than British RATERS. There was also an interaction between RATERS and SEGMENTS. Indian RATERS judged Indian and filtered SEGMENTS somewhat more BRITISH than the British raters (lines three and four).

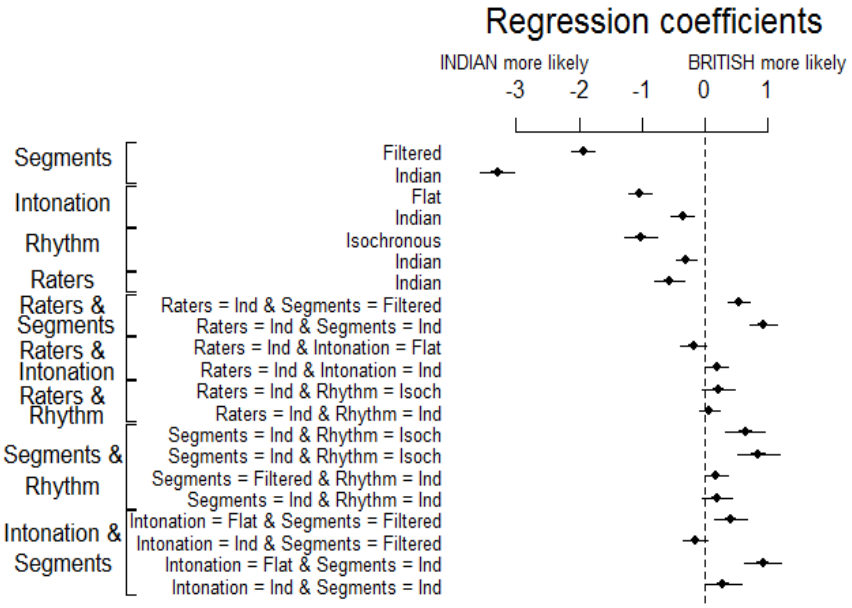

Fig. 3. Coefficients of predictors in the mixed effects model. Each row shows a factor and a value. Negative values, to the left of the dashed vertical zero line, indicate that the factor favours categorisation as INDIAN, positive values as BRITISH. Horizontal lines indicate one standard deviation. Note that all coeffi-

cients have to be interpreted relative to a reference value, which for all factors is BRITISH.[5]

The next two lines illustrate the interaction between RATERS and RHYTHM. Indian RATERS were somewhat more likely to rate Indian and isochronous RHYTHM as BRITISH than the British RATERS (positive values), but the zero line (indicating the BRITISH reference level) is within one standard deviation, indicating low confidence of this result. There was also an interaction between RATERS and INTONATION. Indian RATERS found Indian INTONATION to be slightly more BRITISH, but flat INTONATION to be more INDIAN than the British RATERS.

The remaining eight lines in Fig. 3 show factors involved in interactions with SEGMENTS. There was an interaction between SEGMENTS and RHYTHM.

- When Indian SEGMENTS were combined with isochronous RHYTHM, they made a BRITISH rating more likely than when a stimulus had only one of these properties.
- Furthermore, when Indian SEGMENTS were combined with Indian RHYTHM, they also (but to a much smaller extent) made a BRITISH rating more likely.

Finally, there was an interaction between INTONATION and SEGMENTS:

- Flat INTONATION together with filtered SEGMENTS made a BRITISH rating somewhat more likely,
- Indian INTONATION together with filtered SEGMENTS made an INDIAN rating somewhat more likely,
- flat INTONATION together with Indian SEGMENTS made a BRITISH rating more likely, and
- Indian INTONATION together with Indian SEGMENTS also (but to a smaller extent) made a BRITISH rating more likely.

3.2 Discussion

This pilot study set out to determine whether speakers of IndE can distinguish IndE and BrE based on acoustic information. If they can, the second question is in how far differences in segmental content, rhythm and intonation between the two varieties contribute to this ability. In addition, speakers of BrE participated as a

5 This figure was plotted in R using the coefplot2 package (Gelman and Hill 2006).

control group to determine whether IndE and BrE speakers rely on the same acoustic cues in dialect discrimination.

In order to answer these questions, resynthesised stimuli mixing or suppressing these cues were used in a forced-choice listening experiment. The forced-choice paradigm is a well-established method in the study of speech perception and psychology in general (see, for example, Boothroys 1985, Hartmann 1997). It was chosen for the present experiment because most of the stimuli, consisting of a mixture of cues from both dialects, were inherently ambiguous. For example, faced with a stimulus whose intonation was British and whose rhythm was Indian, permitting participants to choose "don't know" as an answer would likely have led to a greater proportion of abstentions. In addition, a desire to avoid "wrong" answers might have led cautious participants to choose the seemingly safer "don't know" category. This would have thwarted the goal of the experiment, which was to access all knowledge, conscious or subconscious, speakers of IndE and BrE have about the segmental and prosodic characteristics of these varieties. If a certain condition, such as low-pass filtered speech, really did not offer participants any acoustic cues, then the answers should be distributed randomly between BRITISH and INDIAN ratings.

With regard to the first question, whether speakers of IndE can distinguish IndE and BrE based on acoustic information, the results show that they have this ability. Regarding the question which kind of acoustic information they rely on, differences in segmental content (factor SEGMENTS) had the strongest influence, which was three times as large as that of RHYTHM and INTONATION.

In order to obscure relevant acoustic information, low-pass filtering (to obscure segmental information), flatlining INTONATION (to obscure intonation as an acoustic cue), and isochronous RHYTHM (to obscure rhythm as an acoustic cue) were used. Although this did not work as intended in the latter two conditions, how they were rated reveals further aspects of what intonation and rhythm patterns the participants considered particularly indicative of IndE phonology.

- Low pass filtered stimuli were judged in between stimuli with Indian and British SEGMENTS, which suggests that the suppression of these cues was successful.
- Removing RHYTHM as a source of information through isochronous resynthesis also did not lead to the intended result. Rather, isochronous RHYTHM was rated more INDIAN than actual Indian RHYTHM.
- Flatlining INTONATION generally did not have the intended effect and was rated more INDIAN than actual Indian intonation. However, this tendency was weaker or non-existent when SEGMENTS were filtered or Indian, as the interactions show.

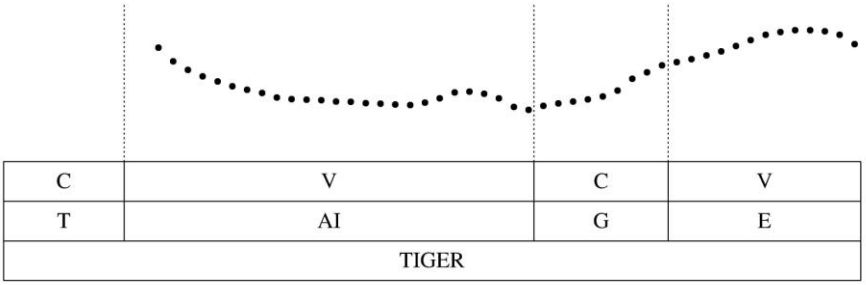

Fig. 4. Example of an L*+H accent in the speech of one of the IndE speakers (L1 Hindi), where the lowest point occurs (L*) occurs close to he boundary of the first and second syllables, and the highest point (H) in the later part of the second syllable.

Interactions between certain factors provided more information on how these conditions were rated. The interactions reveal that isochronous RHYTHM made recordings with SEGMENTS other than Indian or low-pass filtered (i.e. British segments) sound more Indian, also to non-Indian (i.e. British) RATERS. A possible explanation for this is that a tendency towards isochronous rhythm is part of a stereotype of IndE that the British RATERS based their judgements on, and the effect of isochronous RHYTHM might be particularly strong in an otherwise British-sounding recording. This also seems plausible since meso- and basilectal speakers of IndE might show a yet stronger tendency towards syllable-timing than the acrolectal speakers recorded for the stimuli used here.

Flat INTONATION also made INDIAN ratings more likely (and more so than actual Indian INTONATION),[6] but not when combined with Indian SEGMENTAL CONTENT. An explanation might be found in the fact that for "flat" INTONATION a continuously declining contour was used to mirror declination. While little is known about IndE intonation, existing research suggests that at least among some speak-

6 One reviewer raised concerns regarding the forced choice paradigm used in this experiment, that one cannot conclude that a higher proportion of INDIAN reponses with flat INTONATION suggests that this was actually perceived as more characteristic of IndE. Instead, British RATERS might have judged stimuli that they did not perceive as BRITISH simply as INDIAN, and Indian RATERS might have judged stimuli they did not perceive as INDIAN simply as BRITISH. However, if this were true, there would have been an interaction between INTONATION and LISTENER GROUP in the regression analysis, showing that flat INTONATION was judged differently by the two groups. In reality, the opposite turned out to be the case. Flat INTONATION was jugded to be more INDIAN by Indian RATERS than by British RATERS.

ers L*+H accents occur on many content words (Maxwell and Fletcher 2010b). A contour with late rises would then be realised on many syllables. Fig. 4 illustrates this pattern, where the lowest point (L*) occurs at the end of the accented syllable (/taɪ/) and the highest point (H) in the latter half of the second syllable.

Since in L*+H accents the trailing H tone will usually peak in the following syllable, a greater part of the rise might often fall on voiceless portions (i.e. the coda of the accented syllable and the onset of the following syllable), so that the pitch contour is not realised in this part. The audible pitch contour in the accented syllable then consists mainly of a fall, and this might give rise to a stereotype of IndE intonation as consisting mainly of falls. This stereotype might have been the reason why participants in the present experiment associated flatlined intonation (realised as a continuous fall) with IndE. Alternatively, it might be conceivable that the pitch contour that is realised within accented syllables (i.e. often a fall) is more important for accent recognition and discrimination than pitch contour in unaccented or unstressed syllables.

3.3 Influence of Segmental Differences/Low-pass filtering

The preceding section presented a general analysis of the ratings in the form of a mixed effects model (linear regression). In the following, selected individual conditions will be examined to demonstrate their influence and corroborate the analysis presented above.

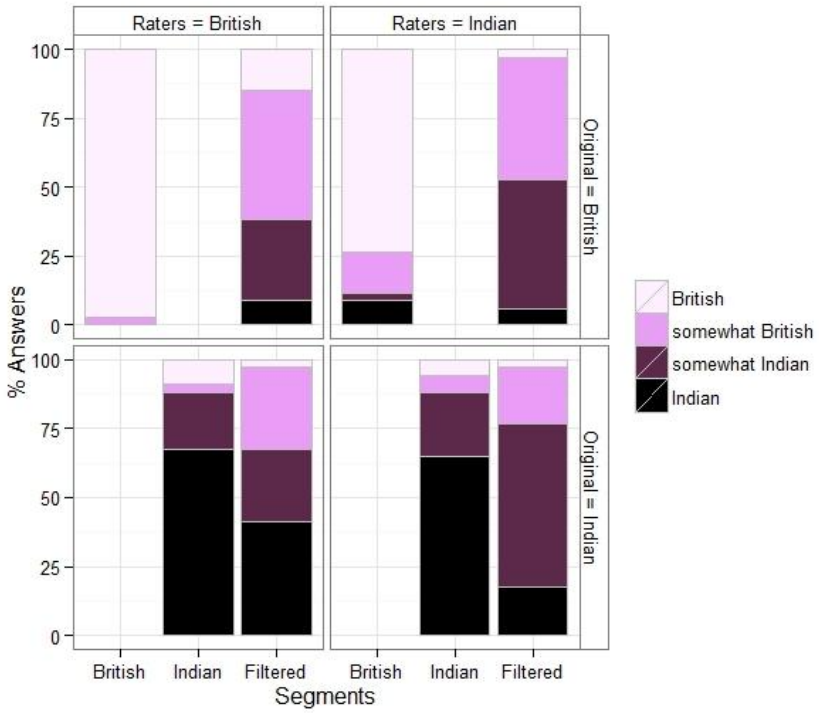

Fig. 5. Influence of segmental differences/low-pass filtering on ratings. In every panel, the left bar shows ratings of unmanipulated and the right bar of low-pass filtered stimuli (there are no bars for British recordings with Indian SEGMENTS and vice versa because the only way of manipulating segmental differences was suppressing this cue with low-pass filtering).

3.3.1 Results

Low-pass filtering generally decreased the likelihood of correctly identifying the variety of English spoken when compared to unmanipulated recordings.

- For the British recordings, identification as BRITISH (sum of "British" and "somewhat British" responses) decreased from 100 % to 62 % for British listeners/RATERS (see top left panel of Fig. 5),
- and from 88 % to 47 % for Indian RATERS (top right panel; both $p<0.001$).[7]

7 All statistical tests reported in sections 3.3-3.5 are unpaired t-tests.

- For the Indian recordings, identification as INDIAN decreased from 100 % to 62 % for British RATERS (bottom left panel), and
- from 88 % to 76 % for the Indian RATERS (bottom right panel; both n.s.).

In all cases, low-pass filtered recordings were much more often rated using the vaguer options "somewhat British/Indian" than "British/Indian". Both rater groups found the Indian low-pass filtered stimuli to be more INDIAN than their British equivalents, but this difference is only significant for British RATERS ($p<0.05$, Indian RATERS $p<0.08$).

3.3.2 Discussion

Many participants reported that they found the low-pass filtered stimuli the most difficult condition of the experiment. Consequently, correct identification rates decreased markedly with low-pass filtering. Also, raters were less confident in their judgements as shown by the dramatic increase of "somewhat judgements". This suggests that segmental differences are a major cue to dialect discrimination, which was also shown by the linear regression analysis in section 3.1, where segmental differences had a greater effect than differences in rhythm and intonation.

Despite all this, Indian low-pass filtered stimuli were still rated INDIAN more often than British low-pass filtered stimuli, and the other way around. This suggests that segmental differences are not the only cue to dialect discrimination, and the linear regression analysis in section 3.1 also showed that differences in RHYTHM and INTONATION have a significant influence on the ratings.

Regarding possible differences between Indian and British RATERS, the present results provide more details on the character of the interaction between RATERS and SEGMENTS that was included in the linear regression analysis. Indian RATERS were less confident in their judgements of filtered stimuli than British RATERS. The Indian RATERS were also more successful than the British RATERS in recognising low-pass filtered Indian stimuli, but British RATERS, in turn, were more successful in recognising low-pass filtered British stimuli. This suggests that both groups are more sensitive to either the RHYTHM or the INTONATION (or both) of their own varieties, respectively.

3.4 Influence of intonation

3.4.1 Results

Since INTONATION interacted with RATERS in the linear regression analysis, the judgements by the British and Indian RATERS will not be pooled.

- For both groups of listeners, resynthesis with British INTONATION was judged to sound more BRITISH than resynthesis with Indian INTONATION, and in turn, Indian INTONATION sounded more BRITISH to them than a flat pitch contour.
- For the Indian LISTENERS, resynthesis with British INTONATION was rated BRITISH (85 %) almost as often as with Indian INTONATION (85 % vs. 84 %, n.s.; see top right panel of Fig. 6),
- but the comparison between British or Indian INTONATION and flat pitch (62 % "British") barely missed significance ($p=0.054$).
- For the British RATERS (top left panel), the comparisons between British INTONATION and a flat pitch contour (100 % vs. 82 %, $p<0.05$), and between Indian INTONATION and flat pitch were significant (96 % vs 82 %, $p<0.05$), but not between British and Indian INTONATION.

Ratings of the resynthesised Indian sentences differed somewhat between Indian and British RATERS, but differences were not systematic and not significant.

- When comparing resynthesis with Indian vs. British INTONATION, the British RATERS judged sentences with British INTONATION to sound less INDIAN than those with Indian INTONATION (91 % vs. 82 %, n.s.),
- but the Indian LISTENERS surprisingly found British INTONATION to sound more INDIAN than the Indian INTONATION (88 % vs 79 %, n.s.).
- The condition with flat INTONATION sounded the most INDIAN to both groups: The British LISTENERS classified it as INDIAN 91 % of the time, on a par with Indian INTONATION and with a slight increase in "Indian" ratings, as opposed to "somewhat Indian" ratings.
- The Indian LISTENERS classified it as INDIAN 94 % of the time (differences n.s.).

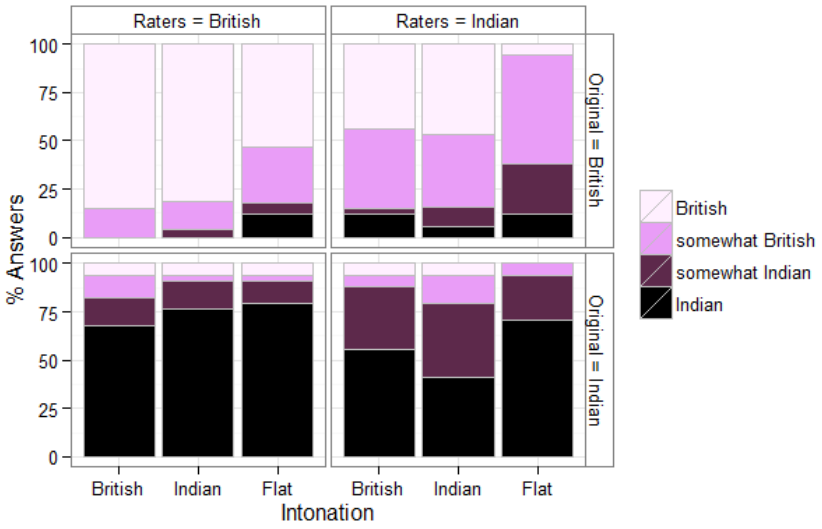

Fig. 6. Influence of INTONATION on ratings of manipulated stimuli. On the horizontal axis, "British" means resynthesis with British INTONATION, "Indian" means resynthesis with Indian INTONATION, and "Flat" means resynthesis with a straight declining pitch contour.

3.4.2 Discussion

Resynthesis with the other variety's INTONATION in most cases caused a small shift towards identification as belonging to the other variety, but differences were not significant. Flat INTONATION made a recording more likely (or at least as likely) to be identified as INDIAN compared to British or Indian INTONATION. This means that the attempt to cancel out INTONATION as a cue to accent was unsuccessful, since in that case flat PITCH should have received ratings between British and Indian INTONATION.

Although the t-tests conducted here on individual conditions did not reveal significant differences between the ratings of British and Indian INTONATION, the linear regression analysis showed that over all conditions, INTONATION was a significant factor influencing dialect identification. However, its influence is moderate in comparison with segmental differences.

Overall, in the conditions examined in this section, resynthesis with British or Indian INTONATION had a more consistent influence on British RATERS than Indian RATERS. Resynthesis with flat INTONATION caused both rater groups to rate stimuli more often as INDIAN, and this tendency was more pronounced for the Indian RATERS than for the British RATERS. In section 3.2, the identification of resynthe-

sis with flat INTONATION as INDIAN was explained with reference to late L*(+H) pitch accents. Although these pitch accents are often described as late rises in the literature, the greater part of the accented syllable will actually have a falling pitch movement up to the lowest point of the contour (which might be delayed until after the end of the accented syllable). While this explanation needs to be verified in future research, it is consistent with the stronger tendency of Indian RATERS to rate flat (falling) INTONATION as INDIAN because Indian RATERS are likely to be more familiar than British RATERS with typical patterns of IndE INTONATION.

An alternative explanation, suggested by one of the reviewers, is that flat (continuously falling) INTONATION was judged more INDIAN by the British RATERS not because they perceived it as more Indian, but because they perceived it as not British. If this were and adequate explanation, then Indian listeners should have rated flat INTONATION as BRITISH (i.e. not Indian). In reality, both Indian and British LISTENERS were more likely to rate flat/falling INTONATION as INDIAN than actual Indian INTONATION. Consequently, the explanation that flat/falling INTONATION embodies a stereotypical aspect of IndE intonation is currently the best explanation of the results.

3.5 Influence of rhythm

3.5.1 Results

The ratings by the British and Indian RATERS were pooled, since RHYTHM did not interact with RATERS. When the British recordings were resynthesised with the RHYTHM of the other British speaker they were rated as "British" 96 % of the time, and resynthesis with Indian RHYTHM somewhat decreased "British" ratings to 89 % ($p>0.05$; see left panel of Fig. 7), and when resynthesised with isochronous RHYTHM, 69 % of the time ($p<0.001$ when compared with British and Indian RHYTHM, respectively).

Resynthesis of the Indian recordings with British and with Indian INTONATION were both rated as 85 % "INDIAN, but there is a slight increase of "somewhat British" and "Indian" ratings (as opposed to "somewhat Indian"), suggesting that resynthesis with Indian RHYTHM made the listeners somewhat less secure about the BRITISH and somewhat more secure about the INDIAN ratings. Resynthesis with isochronous RHYTHM was rated INDIAN slightly more often (88 %, n.s.).

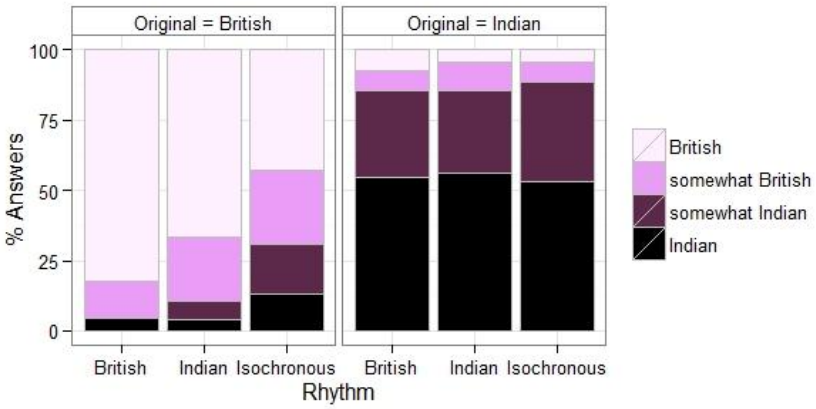

Fig. 7. Influence of RHYTHM on ratings of manipulated stimuli.

3.5.2 Discussion

Resynthesis of the British sentences with Indian RHYTHM only caused a moderate and insignificant decrease in BRITISH ratings. Isochronous RHYTHM, on the other hand, caused a significant decrease of ratings as BRITISH. The ratings of the Indian sentences were not significantly influenced by the manipulation of RHYTHM, although there was a small increase in INDIAN ratings in the isochronous condition compared to British and Indian RHYTHM.

The results presented in this section underscore the findings of the linear regression analysis presented in section 3.1, where SEGMENTS turned out to have stronger influence on accent discrimination than RHYTHM. Nevertheless, across all conditions used in the present experiment (of which only a few can be presented in detail), RHYTHM was shown to be a factor with significant influence on the ratings.

The fact that RHYTHM had a stronger influence on stimuli that were originally British (and thus had British INTONATION and SEGMENTS, in this condition), but not on stimuli that were originally Indian, might be due to a ceiling effect in the case of recordings that were originally Indian.

4 Conclusion

This pilot study set out to determine (1) whether speakers of IndE can distinguish IndE and BrE based on acoustic information, (2) whether they rely on differences in segmental content, rhythm and intonation, and whether any of these cues are more important, and (3) whether there are any differences in the use of these acoustic cues between participants who speak IndE and BrE.

The general hierarchy of cues involved in distinguishing Indian and British accents appears to be first of all differences in the realisation of segments, followed by intonation and speech rhythm, with all three factors contributing significant effects. Both rater groups generally agreed in their judgements. Exceptions are mostly due to the British raters outperforming the Indian raters, which might be due to the former being more familiar with IndE after taking part in a linguistics class on World Englishes. On the other hand, IndE was not a particular focus of the class, and the Indian raters were all enrolled in English-language related degrees and mostly taught in English-medium schools, which would suggest a certain familiarity with accents of English spoken outside India.

The suppression of cues through flatlining pitch and resynthesising stimuli with an isochronous rhythm revealed further insights into what features of IndE phonology are perceived as characteristic in comparison to BrE phonology. Both were interpreted by the two groups, but more consistently so by the British raters, as sounding more Indian than the actual Indian variants. Isochronous rhythm and L*(+H) pitch accents might form part of a stereotype of IndE that the British raters based their judgements on. However, recent research by Olga Maxwell (p.c.) indicates that this type of pitch accent might not be used by all speakers of IndE.

The results also show that selective resynthesis and mixing of the acoustic cues speech rhythm, intonation and segmental differences/low pass-filtering can be used to establish how much these cues contribute to the recognition of IndE and BrE accents by speakers of these varieties. The evidence presented here shows that this technique is promising and can produce useful results. Most conditions, even those involving three levels of manipulation, produced meaningful results, although the numbers of speakers and participants involved were small.

An intended future study with larger numbers of speakers and participants involved will allow more reliable conclusions (reported in Fuchs 2014). The inclusion of more speakers will also allow a more fine-grained analysis of results, correlating actual speech rhythm measurements with ratings. In this way, it might be possible to quantify more directly how much (variation in) speech rhythm contributes to dialect discrimination.

Appendix

R code for linear regression analysis:

```
  model<-
lme(resnum~pitch+segments+rhythm+pitch*participant_orig
in+segments*participant_origin+rhythm*participant_origi
n+segments*pitch+segments*rhythm,random=~1|name,data=di
sam)
```

```
Linear mixed-effects model fit by REML
       AIC      BIC    logLik
  11645.49 11794.35 -5798.746
```

	numDF	denDF	F-value	p-value
(Intercept)	1	3618	4.4595	0.0348
pitch	2	3618	149.1874	<.0001
segments	2	3618	997.1169	<.0001
rhythm	2	3618	22.4892	<.0001
raters	1	3618	0.2328	0.6295
pitch*raters	2	3618	12.2749	<.0001
segments*raters	2	3618	41.5933	<.0001
rhythm*raters	2	3618	1.4663	0.2309
pitch*segments	4	3618	17.3666	<.0001
segments*rhythm	4	3618	7.2638	<.0001

Table 3. Summary of ANOVA of linear regression model.

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