A SOCIO-PHONETIC STUDY OF THE DRESS, TRAP AND STRUT VOWELS IN LONDON ENGLISH

Miho Kamata

Abstract

This study presents a preliminary empirical socio-phonetic investigation of the realisations of the three short vowels DRESS, TRAP and STRUT (Wells 1982a), produced by eight male Londoners, attempting to discover a possible vowel shift involving these vowels in London speech[1]. Two social characteristics of the subjects, age (young vs. old) and social class (working class (WC) vs. upper middle class (UMC)), are considered in three different speech styles; Interview Style, Reading Passage Style and Word List Style. Making use of a vowel formant normalisation technique called *S-procedure* (Watt & Fabricius 2002), a direct comparison of vowel realisations for several individuals are shown on the same plot. As a result, different directional vowel shifts are found between WC and UMC. This paper will also briefly consider, firstly, a conceptual issue regarding accent varieties in London, secondly, a sociolinguistic issue for social class classification based on occupations, and finally a methodological issue in terms of vowel normalisation.

1. Introduction

London has often been claimed to have different accents on a continuum with Received Pronunciation (RP) and Cockney being its extremes as an acrolect and a basilect. There are several mesolectal varieties referred to by a number of possibly overlapping terms such as 'London (or, more generally, south-eastern) Regional Standard' and 'Popular London' speech (Wells 1982b: 302-303), 'Estuary English' (Rosewarne 1984), 'Post-Modern English' (Maidment 1994), 'New London Voice' (McArthur 1994) and 'South East London Regional Standard' and 'South East London English' (Tollfree 1999)

London, as the capital of England, can be considered to have historically played an important leading part in the phonetic development of RP. This seems specially true for the case of 'mainstream RP' (Wells 1982b: 279).; it has been greatly influenced by trends/features spreading from working-class urban speech, particularly that of London (Wells 1982a: 106). In this way, accents in London seem to have been involved in RP in one way or another. Recognising London as the source of most innovations in the standard accent, Wells also comments as follows :

[1] This is a preliminary report of my currently ongoing socio-phonetic PhD research into the socio-phonetic study of accent variations in London speech, particularly focusing on five phonological variables i.e. STRUT, TRAP and STRUT vowels, T-affrication, and H-dropping.

> With the loosening of social stratification and the recent trend for people of working-class or lower-middle-class origins to set the fashion in many areas of life, it may be that RP is on the way out. By the end of the [20th] century everyone growing up in Britain may have some degree of local accent. Or, instead, some new non-localizable but more democratic standard may have arisen from the ashes of RP; if so, it seems likely to be based on popular London English. (Wells 1982a: 118)

Recognising this potential in London English, we are greatly motivated to examine it more closely, not only as one of the regional varieties in England, but also as an innovative variety which has had a great influence on RP.

The phonological variables selected in this paper are the vowels of the STRUT, TRAP, and DRESS lexical sets (Wells 1982a). These three short vowels were chosen because they have been reported by a number of phoneticians and variationists to shift in particular directions in RP and London English during the course of the 20th century, with a certain degree of interrelatedness. Wells (1982b: 291-292), for example, points out the variable merger of /æ/ and /ʌ/ in contemporary RP due to perceptual similarity between the newly current [a] of TRAP and the fronted realisations of STRUT. He continues that this lowering and centring of /æ/ is associated with that of /ɪ/ and /e/ in a process called *chain shift*, as discussed in Hughes, Trudgill & Watt (2005: 48), although it is not clear whether the change is in a *push-chain* or in a *drag-chain* (Wells 1982b: 292).

This paper pays particular attention to the acoustic characteristics of these vowels elicited from speakers born and bred in London. In addition, the paper provides a brief discussion on the following points: (1) the concept of accent varieties in London (§2-1), (2) the way of social class classification based on occupations from a sociolinguistic point of view (§3-2-2), and (3) a methodology of vowel normalisation (§3-6). In relation to the latter, the F1 and F2 frequencies of the vowels are measured, and then transformed into *S-units* by a vowel formant normalisation technique called *S-procedure* (Watt & Fabricius 2002). The procedure allows direct visual and statistical comparison for multiple speakers regardless of their physical differences.

2. Background and Research Questions

2.1. Accent situation in London –from RP to Cockney

London has often been claimed to traditionally have different accent varieties: RP, Cockney, and the varieties in between.

RP is socially regarded as the most prestigious accent, and perceived as being spoken by upper-class or upper middle class people; geographically, on the other hand, it has often been claimed to have no relation to the region where the speaker comes from. However, as mentioned above, it is also true that it was originally based on the speech of educated speakers of southern British English (Coggle 1993: 23, Trim 1961/62: 29), particularly on that of the London region as a place for the centre of politics, commerce, and the presence of the Court (Cruttenden 2001: 78), and typologically it has its origins in the southeast of England in a sense that unlike accents from the southwest of England, for example, it is a non-rhotic accent, and unlike the accents of the north of England, it has /ɑː/[2] rather than /æ/ in the lexical sets of *bath* and *dance* (Trudgill 2002: 172). A recent empirical study by Fabricius (2000, 2002) discovers more use of t-glottalling in the speech of ex-public school students at University of Cambridge; this may also be support for possible influence of London accents on RP. In short, RP is closely related to the social status of the speakers, therefore it is an extremely significant marker of upper class groups in all parts of England including London. Because of its social implication, many adopt RP (cf. 'adoptive RP' in Wells 1982b: 283-285). Despite its prestige, on the other hand, it has been estimated that only about 3 to 5 percent of the whole English population speak RP (Trudgill 2002: 171-2, Hughes *et al.* 2005: 3); it is, therefore, conceivable that only a few speak RP in London.

On the other end of the continuum, there is another accent in London, Cockney[3], which is related to both the social class and geographical area the speaker belongs to. Socially, Cockney is often stigmatised as a vulgar accent; it is presumed to be used by people of the lowest social strata of the city. Geographically, it is only heard in the London area. To be more accurate, this variety is particularly associated with the innermost areas of east London – the East End – such as Bethnal Green, Stepney, Mile End, Hackney, Whitechapel, Shoreditch, Poplar, and Bow (Wells 1982b: 302). Strictly speaking, it is often said that Cockney is the speech of working-class Eastenders, often called 'true Cockney', who were born within the sound of Bow Bells (the bells of St Mary-le-Bow, Cheapside) (Barltrop & Wolveridge 1980: 2, Coggle 1993: 23, Crowther 1999: 118).

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[2] Trudgill (2002) describes as /aː/.

[3] Cockney is generally considered not only as an accent but as a dialect in that it possesses many of its own special vocabulary and usages, including rhyming slang (Wells 1982: 302, Cruttenden 2001: 87); however, we are only concerned with its pronunciation here.

In addition to these traditional accent varieties, mesolectal varieties (or a certain type of speech, at least) between RP and Cockney have been identified by a number of linguists as referred to in the previous section.

Rosewarne's term 'Estuary English' has been widely commented on not only by linguists but also by British journalists since he coined the term in 1984. Despite its increasing recognition by the general public, the term 'Estuary English' ('EE', hereafter) has been controversial. Trudgill (1999: 80-82), for example, claims that 'EE' is an inappropriate term not only because it suggests that it is a new variety, which is not true, but also because it suggests that it is a variety of English confined to the banks of the Thames Estuary, which is not true either. The name, 'EE', is new, but the phenomenon is not new. According to Wells (1997), there is a tendency for features of London speech (i.e. 'popular London' in his term) to spread out geographically to other parts of the country and socially to higher social classes, and he points out that this is the continuation of a trend that has been going on for five hundred years or more.

Although the term 'EE' and its existence is controversial, 'EE' (if we assume that it exists) is often described as a middle ground between two extremes, i.e. RP and Cockney. That is, like RP but unlike Cockney, the speakers of this variety are speakers of the standard English dialect, i.e. they speak lexically and grammatically standard English; however, like Cockney but unlike RP, they speak with a localised accent including some of the typical phonological characteristics of Cockney. The relationship between these three accents (i.e. RP, Cockney, and EE) may possibly be explained in relation to style-shifting by the following diagram, which was suggested by Kamata (2001: 17-38):

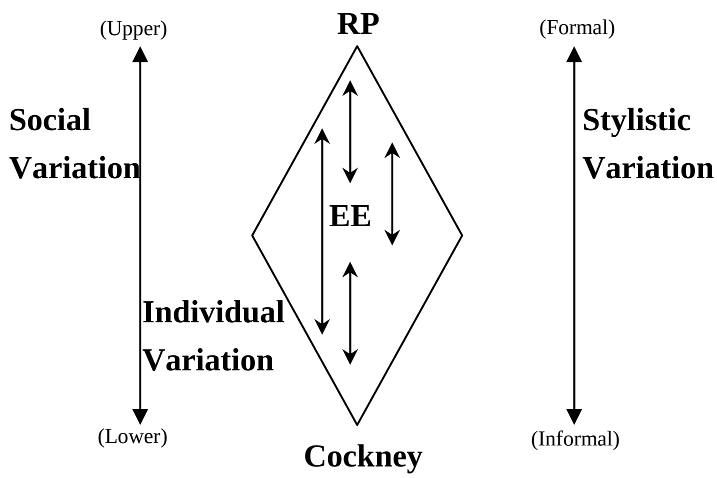

Figure 1. The parallelism of the relation between three accents in London, social variation, and stylistic variation
(Modified From Kamata 2001: 30)

Figure 1 is a modified version of the traditional triangle or pyramid model for the relationship between status and accent (Hughes *et al.* 2005: 10). The figure represents the parallelism of the relation between the three accents in London (RP, Cockney and 'EE'), social variation, and stylistic variation. RP at the top of the rhombus is socially the highest, and the most formal style. Cockney at the bottom of the rhombus is socially the lowest, and stylistically the most informal; only this accent is certain to give information about the speakers' geographical area. The reason for having the top and bottom vertices of the rhombus is that not only the number of true RP speakers but also that of true Cockney speakers can be considered few because, according to Wells (1982b: 302), most working-class Londoners do not qualify as 'true Cockneys' in its strict definition quoted above (§2-1) in the sense that they were not born in the East End. Instead, majority of the speakers in this region could fit into anywhere within the rhombus with a possibility to be called 'EE' speakers. Therefore, 'EE' within the rhombus includes many individuals, each of whom may be anywhere along the continuum from RP to Cockney, with a certain range of stylistic variation in their own speech.

We do not go into discussions about accents in London in detail in this paper. Instead, it is presumed that speech in London can be categorised at least into two varieties; a more RP-type of speech (i.e. schematically near to the top of the rhombus in Figure 1) mainly spoken by middle class people, and a more Cockney/London-type of speech (i.e. schematically somewhere in the middle or the bottom of the rhombus) mainly spoken by working class people. We decide to call the former type of accent as 'London RP', the latter as 'London Regional', and any accent spoken in London or by Londoners as 'London English' (as in the title of this paper) as a cover term for both in general.

2.2. DRESS, TRAP and STRUT vowels in RP and London

The realisation of DRESS, TRAP and STRUT differ in accent varieties in London (c.f. Wells 1982b, Tollfree 1999); however, it seems that they have always had a certain degree of correlation as adjacent short vowels.

2.2.1. DRESS in RP and London

The DRESS vowel, traditionally called 'short E', is discussed by Wells (1982a: 128) as a phonetically relatively short, lax, front mid unrounded vocoid in RP, which should be transcribed as [e̹][4] or [ɛ̝]. Cruttenden (2001: 110) states that the general RP variety tends to be closer to [ɛ] than to [e]. Hughes *et al.* (2005: 48) represents it as /ɛ/ which is presumably the similar quality described by Wells (1982a: 128) and

[4] Wells transcribes as [e̹] (1982: 128).

Cruttenden (2001: 110). Most other accents have a vowel in this lexical set generally similar to this vowel quality (Wells 1982a: 128). The diphthongal realisations [ɛᵊ] or [eᵊ] can also be heard, being perceived as affected (Hughes *et al.* 2005: 48, Cruttenden 2001: 110). The height and degree of centralisation of /e/ (as well as /ɪ/), however, vary; relatively close and peripheral qualities are associated particularly, but non-exclusively, with old-fashioned RP, while relatively open and central qualities (presumably transcribed [ë̞] or [ɛ̞̈]) are common with younger speakers (Wells 1982b: 291, Hughes, Trudgill & Watt 2005: 48). The similar lowering of this vowel is also found by Tollfree (1999: 165) in her SELRS data (which is considered to be equivalent to our 'London RP' here) in which older speakers have [ɛ] and some [ɛᵊ] variants while younger speakers have [ɛ] or more open variant form [ɛ̞]. Hawkins & Midgley (2005: 188) observe not only the lowering (i.e. higher in F1) but also a slight backing (i.e. lower in F2) for this vowel from their oldest to youngest RP male speakers in their acoustic study of RP monophthongs. They identify their youngest speakers (born in 1976-1981) as a so-called 'break-group' whose members, by their definition, have more dispersed formant frequencies than members of the other age groups, which implies that the lowering of this vowel started in some young people's speech at least by 1981 (the latest possible date of birth for the youngest group), but not as early as 1966 (the latest possible date of birth for their next age group of those born in 1961-1966) in their data (Hawkins & Midgley 2005: 192)[5]. There is more evidence for the backing of this vowel in a real-time acoustic study by Harrington, Palethorpe & Watson (2000: 70) in Queen Elizabeth II's speech from her Christmas messages in 1950s, 1960s and 1980s (i.e. a lower F2 in her 80's speech compared with her 50's and 60's speech)[6]. Thus, this vowel in RP seems to be not only ***lowering*** as mentioned by Hughes, Trudgill & Watt (2005: 48), but also ***backing*** in current RP (Hawkins & Midgley 2005: 188).

The DRESS vowel of traditional Cockney is described by Sivertsen (1960: 53) as /e/, an unrounded, front, between half-close and half-open vocoid, which should be transcribed as [e̞] or [ɛ̝]. The closer variants of this vowel are not only found in old-fashioned types of RP, but also in those of Cockney (Wells 1982a: 128, Cruttenden 2001: 110), while more open realisations are found among younger speakers (Wells 1982a: 128, Tollfree 1999: 165). As referred by Torgersen & Kerswill (2004: 32), the evidence for the closer type of variants by older Cockney

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5 According to Hawkins & Midgley (2005: 192), a 'break-group' is a generational group of people who are in a situation to be able to choose more conservative or more progressive pronunciations individually from a range of variants available to them due to incipient rapid sound-change.

6 On the contrary to the F2 trend, Queen's F1 goes against the current trend of lowering; that is, there is an F1 decrease in this vowel in the Queen's speech from the 50's to the 80's (Harrington *et al.* 2000: 72). This may be consistent with the recent tendency that older speakers have a lower F1 frequency than younger speakers.

speakers can be found in the description of Matthews (1938: 169) as in 'git' for *get* and 'cimitery' for *cemetery*. The tendency towards lowering is corresponding to Beaken's (1971: 150) argument that the ***lowering*** of this vowel is a feature of 'modern' Cockney in his time (i.e. more than 30 years ago). Similar lowering of this vowel is also found in more recent London data by Tollfree (1999: 164); in her SELE data (i.e. which is considered to be equivalent to our 'London Regional' here), older speakers have [ε] with some [ε^{ə}] while younger speakers have [ε] or more open variant form [ε̞]. This lowering is also found in Ashford in Kent, about 40 miles south-east of London (Torgersen & Kerswill 2004). In the case of Cockney, some other diphthongal variants, [e^{ə}~e^{ɪ}~ε^{ɪ}], with a closing offglide before certain voiced consonants have been reported by Sivertsen (1960: 54), Wells (1982a: 129) and Cruttenden (2001: 110). Thus, this vowel in London Regional seems to be ***lowering*** at least in the last few decades.

2.2.2. TRAP in RP and London

The TRAP vowel, traditionally called 'short A', has the stressed vowel /æ/ in RP (Wells 1982a: 129). Phonetically, according to Wells (1982a: 129), it is a front nearly open unrounded vocoid, [æ], approximately halfway between cardinal vowels 3 ([ε]) and 4 ([a]). Recently, however, this [æ] variant seems to be confined mostly to older or more conservative speakers which in some cases may cause confusion with /ε/ (Hughes *et al.* 2005: 48). Many researchers agree that present-day RP TRAP has a ***more open*** [a]-like monophthongal quality in England (Wells 1982a: 129, Bauer 1985&1994, Harrington *et al.* 2000: 73, Cruttenden 2001: 83 and 111, Hughes *et al.* 2005: 48), which is even remarked by Cruttenden (2001: 83) as a well-established change within RP. Interestingly, Wells (1982a: 129) comments that it may possibly be a reaction against the closer [ε~ε^{ɪ}] type of realisation associated with Cockney. There is also an acoustic report of ***backing*** for this vowel (i.e. decrease in F2) in data from female speakers born between 1919 to 1960 by Bauer (1985, 1994: 117), who states his data agree with the study by Henton[7] (1983, cited in Bauer 1994: 119) which compares vowel formant frequencies between the male RP data from Wells (1962) and those from Henton (1983); similar backing (i.e. F2 decrease) as well as lowering (i.e. F1 increase) for this vowel is also found in the Queen's later speech (Harrington *et al.* 2000: 70). In the study of Hawkins & Midgley (2005: 188), the similar lowering (i.e. F1 increase) and a slight backing (i.e. F2 decrease) are found from their oldest to youngest RP male speakers; for this vowel, they identify two age groups (born in 1946-1951 and 1961-1966) as 'break-groups' implying that this lowering phenomena

[7] Not all Bauer's results agree with those obtained by Henton (1983). Bauer finds, as mentioned, an evidence for lowering of this vowel, while Henton finds an evidence for its rising (Bauer 1994: 119).

presumably began at or before the early 1950s (the latest possible date of birth for the group), but not as early as 1936 (the latest possible date of birth for their next age group of those born in 1928-1936). The latest acoustic study for this TRAP vowel in the configuration with STRUT vowel in RP is conducted by Fabricius (2006) who compares acoustic measurements of male RP speakers from her unpublished corpus collected in Cambridge with other data from several published corpora (i.e. Deterding (1997), Wells (1962), Hawkins & Midgley (2005), Harrington *et al*. (2000)). Her data show an interesting ongoing change that she names 'TRAP/STRUT rotation' in the short vowel space across generations due to the juxtaposition of TRAP and STRUT vowels between its horizontal and vertical alignments over the course of the twentieth century[8]. She presumes that this is the ongoing result of approximately half a century of TRAP backing and lowering, which can be seen to trigger the observed rotating of the STRUT vowel upwards into a mid-central position towards schwa and ultimately towards DRESS (Fabricius 2006: 3). Thus, the findings in the study of Fabricius (2006) are also indicating that the TRAP vowel is lowering and backing. This [a], or possibly the retracted variant [a̠], which is perceptually very similar to the fronted realisation of /ʌ/ in RP, may cause confusion with /ʌ/ (Wells 1982b: 291, Hughes *et al.* 2005: 48), or may even result in neutralization of these two phonemes (Cruttenden 2001: 111). Lengthening of this vowel is also common in some words in the south (especially the southwest) of England (Wells 1982a: 129-130, Cruttenden 2001: 111). The closer variants, possibly with a centring offglide, [ɛ~ɛᵊ] or [æ̝~æᵊ], are perceived refined, affected or old-fashioned (Cruttenden 2001: 111, Hughes *et al.* 2005: 48). The opening diphthongs [ɛæ~eæ] can also be heard among U-RP (Wells 1982b: 281). Thus, TRAP in RP has been undergoing ***lowering*** and ***backing***.

The TRAP vowel of traditional Cockney is described by Sivertsen (1960: 53), Wells (1982a: 129) and Cruttenden (2001: 112) as [ɛ], an unrounded, front, half-open vocoid slightly closer than RP. As mentioned by Torgersen & Kerswill (2004: 31), the evidence for this closer type of old Cockney TRAP vowel can also be seen in the transcription by Matthews (1938: 79), as in [keb] for *cab* and [ben] for *ban*. The majority of realisations from the data of Hurford (1967) cited in Torgersen & Kerswill (2004: 31) are [ɛ], [æ] and [a], with a raised realisation [e] and some retracted realisations [ə] or [ɐ]. This closer variant [ɛ] as well as the diphthongal realisation [ɛᶦ] have been thus associated with Cockney (Wells 1982a: 129, Wells 1982b: 305). Slightly opener realisations [æ~æː] are also found in a more recent study by Tollfree

8 For details, the short vowel space in RP is observed in her data from an 'early triangle' configuration of the vowel space with STRUT as the lowest point and with TRAP being above it ans more front, through a 'quadrilateral' configuration in the mid-twentieth century with TRAP and STRUT on a similar level, to at last in presumably the later twentieth century a 'later triangular' configuration with TRAP lowest in an open central position and with STRUT above it in a mid central position (Fabricius 2006: 18-19)

(1999: 166), in her SELRS and SELE data, which is slightly lower than the Cockney variant [ɛ̞] found by Hughes *et al.* (2005: 74) who also identify a diphthong [ɛi]. Another possible diphthongal realisation [ɛᵊ], the same as a refined, affected or old-fashioned RP variant, is also pointed out by Cruttenden (2001: 112). The current trend of this vowel in London, thus, can be assumed to also be towards a ***more open*** [a]-like monophthongal quality along with the trend in England as mentioned above.

2.2.3. STRUT in RP and London

The STRUT vowel traditionally called 'short U', according to Wells (1982a: 131-132), has the stressed vowel /ʌ/ in RP; he describes it in present-day RP as a relatively short, half-open or slightly opener, centralised back or central, unrounded vocoid somewhere like [ɐ]. Similarly, Cruttenden (2001: 113) describes it as having a centralised and slightly raised quality [ä̝], as well as a more back variant [ʌ̝̈] with upper-class speakers (i.e. 'Refined RP' speakers in his term). Tollfree (1999: 166) finds [ɐ] or [ʌ̝] in her SELRS data. Additionally, older speakers may realise it as a rather more retracted vowel (Hughes *et al.* 2005: 49). Consequently, it may be assumed that the vowel is ***fronting***. In Bauer's (1985) study, however, even though he states that his data suggest a general fronting, they show no evidence that this vowel is more retracted in his older RP speakers and the data even appear to indicate some ***backing*** from a centralised position (Torgersen & Kerswill 2004: 29-30). In the study of Harrington *et al.* (2000: 72), similar backing is also found in the Queen's speech in later years (i.e. 60's and 80's compared with 50's) in the form of a decrease in F2. Unlike those aforementioned studies, however, the data of Hawkins & Midgley (2005: 188) indicate that this vowel is rather stable across their four age groups of RP male speakers.[9] Moreover, the findings from Fabricius (2006) even suggest the ***rising*** of this vowel in the latter twentieth century, as can be found in the study of Henton (1982: 358). Thus, although many studies identify changes in the quality of STRUT in RP in the last century, there is not a consistent agreement on the direction of movement (Harrington *et al.* 2000: 66, Fabricius 2006: 2).

The STRUT vowel of traditional Cockney is represented by Sivertsen (1960: 83) with a symbol [ʌ], not as a back vowel, but as an unrounded, front vowel between open-mid and open, which is not very different from the RP TRAP but not as front as that. Wells (1982b: 305) describes this vowel in Cockney as ranging from a fronted [ɐ̟] to a striking front quality like that of cardinal 4, [a], as described by Cruttenden (2001: 113). Similarly Tollfree (1999: 166) finds [ɐ] and [a] in her SELE data.

[9] Hawkins & Midgley (2005: 192) find evidence of incipient change of F1 dispersion in the STRUT vowel in their youngest age group (born in 1976-1981) which is identified as a 'break-group' for this vowel; however, they observe that it is very tentative in a sense that all other age groups have similar degrees of dispersion for F1.

Hughes *et al.* (2005: 73) identify /ʌ/, realised as [a̝]. Torgersen & Kerswill (2004: 32) refer to the findings of Hurford (1967: 382) that one of the oldest speakers has a front variant [a], however, most of the speakers have an open central variant [ɐ̞] and some others have a central [ɐ], from which they conclude that extreme fronting which STRUT had undergone in the first half of the 20th century had been reversed (i.e. *backing*) by the middle of 20th century. Similar ***backing*** of this vowel is also found in the data in Ashford in Kent in the study of Torgersen & Kerswill (2004: 40).

2.2.4. Correlations among DRESS, TRAP and STRUT

The various descriptions in the previous sections are summarised in Figure 2 in (London) RP and London Regional accents respectively.

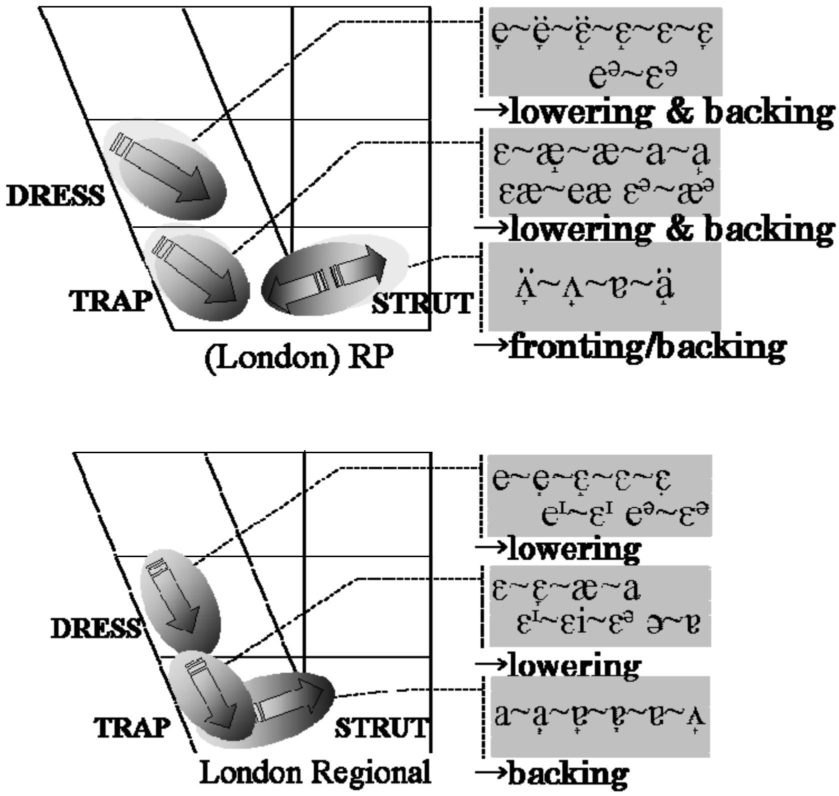

Figure 2. Diagrams of possible realisations and changes in DRESS, TRAP and STRUT vowels in (London) RP and London Regional accents in vowel quadrilaterals from various studies (c.f. §2.2)

The figure shows possible current tendencies of the movement, indicated by arrows, for the three vowels. All the possible variants for each vowel are indicated in the right shadowed boxes whilst the ovals indicate the region of the variants within the vowel quadrilaterals.

There have been reported a number of interrelations among DRESS, TRAP and STRUT possibly because of their complicated vowel movements. In RP, on the one hand, Wells (1982b: 292) mentions variable merger of TRAP and STRUT for some speakers presumably due to the lowered and centralised KIT and DRESS. Hughes *et al.* (2005: 48) comment on possible confusion of older speakers' [æ] for TRAP as a realisation for DRESS. In London Regional, on the other hand, replacement of TRAP with DRESS (Sivertsen 1960: 59), confusion between TRAP and STRUT (Beaken 1971: 150) and overlap of TRAP and DRESS (Beaken 1971: 150) are reported.

2.3. Research questions

Although a number of studies have shown substantial evidence for a complex shifting of these three vowels over the last century, it is still not very clear in which directions these three vowels are moving and the correlations among them. With regard to London Regional accent in particular, compared to RP, there are fewer acoustic studies available, which prevents us from revealing their possible recent movement, even though it has innovative and important implications for RP in England.

In order to pursue a clearer picture for these three short vowels in London English in relation to those in RP, the following questions are considered in this paper:

(1) Are the three short vowels (DRESS, TRAP and STRUT) in London RP and London Regional shifting?
(2) If they are shifting, in which directions are they shifting?
(3) Is there any indication of social effects on the movements of these vowels?

For the first and second questions, age comparison in each social class is carried out in an apparent-time investigation; in details, mean values of F1 and F2-F1 for each vowel between the two age groups in each social class are compared statistically. For the third question, social class and speech styles are compared.

3. Method

3.1. Fieldwork sites

Two places were selected as fieldwork sites for the research project. One was London, and the other Leeds in which the author was based. The data were collected in May 2004 in Leeds and in May, June and September 2004 in London.

3.2. Subjects

During the period of fieldwork (May, June and September 2004), a corpus of speech data from 75 informants was obtained through several social network connections[10]; 9 informants were interviewed in Leeds, and the other 66 in London. Nine male speakers (3 recorded in Leeds and 6 in London) out of these 75 informants were selected for the current study, based on their regionality, age and social class.

3.2.1. Regionality

The most important point for the selection of the speakers was their regionality, i.e. where they were born and where they had lived. The criterion for regionality was that the subjects had to be so-called ‘Londoners’. In any case, people who were (ideally born and) brought up in London or who claimed to be Londoners were called for as potential subject. It was left open to individual interpretation where the boundary for London lay and what type of people the word *Londoners* indicated. For this reason, although ‘London’ generally means the administrative area of Greater London containing 32 London Boroughs, of which twelve (plus the City of London) make up Inner London and twenty Outer London, some of the initial 75 speakers who claimed to be “*Londoners*” were actually not from Greater London but from adjacent areas around London (i.e. Hertfordshire, Essex, Kent, Buckinghamshire, Berkshire or Surrey) or even from other parts of England in case that they either were only born in London or had lived in London for a short period. Their regional information was elicited in the recorded interview session and detailed on the questionnaire.

Figure 3 shows the administrative area of Greater London (which will be simply called ‘London’ hereafter) and surrounding counties. It is indicated on the map where the nine speakers come from. Figure 4 presents detailed residential information.

[10] The social networks obtained in the whole data are mainly within a school, a workplace, a social services group and a religious community.

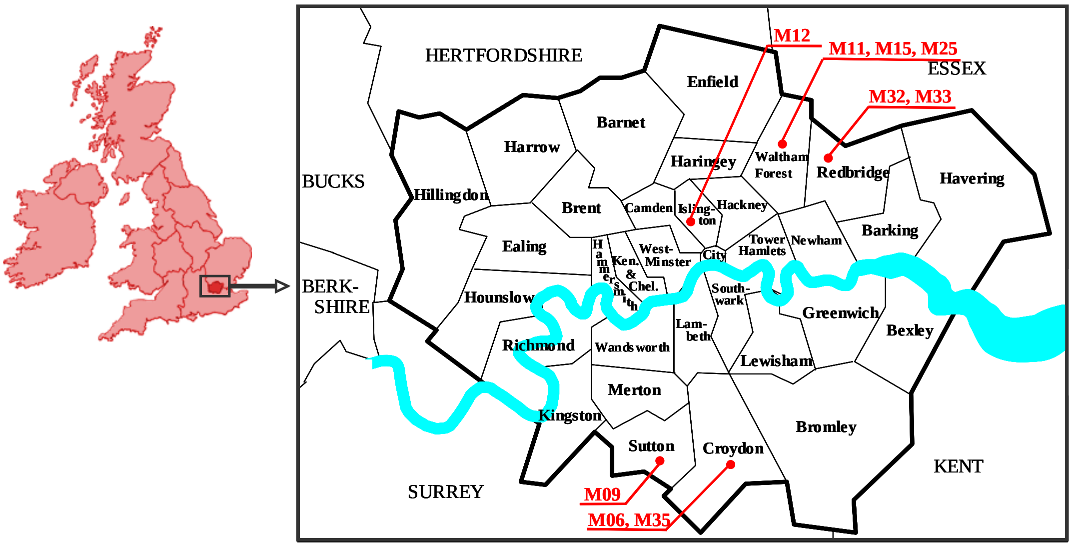

Figure 3. The map of the administrative area of Greater London (containing 32 London Boroughs) and surrounding counties

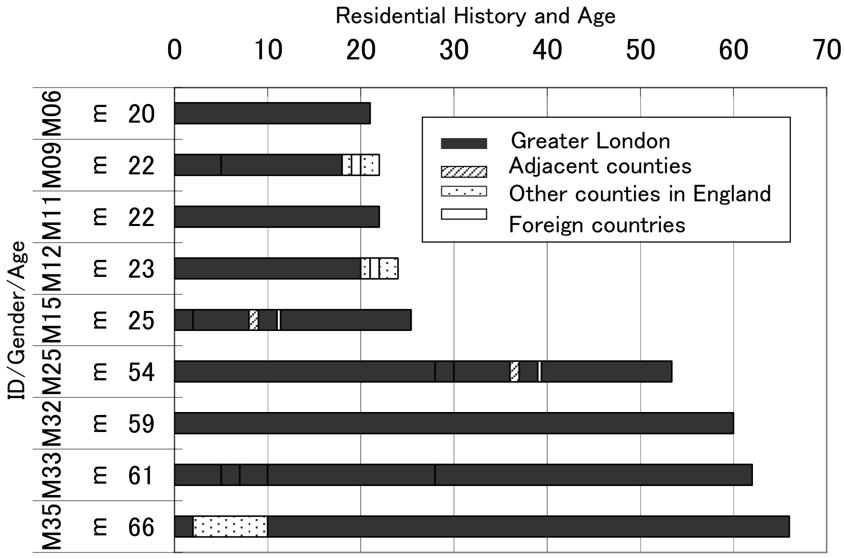

Figure 4. Speakers' residential information

The nine speakers were all born in London, brought up there and had lived in London almost all their lives. One particular exception to be noted for M35; he had spent eight years of his childhood (from age 2 to 10) in other counties (mainly in Cambridgeshire) (where he had been evacuated during the war). Both M09 and M12 had always been living in London until they started their university education outside of London, in Leeds, with one year abroad experience in Japan (M09) and in Russia (M12), respectively. In the case of M06, although his residential information shows that he had only lived in London (as claimed by himself), he had actually lived in Leeds for a few years to attend university. M25 and M15, who were father and son,[11] had spent a few months in a different country (i.e. Australia), because of the father (M25)'s job. For the purposes of this investigation all will be treated as "*Londoners*".

3.2.1. Age

Subjects were subdivided into two age groups, Young and Old. The Young speakers were five in total and born between 1979-1983, and the Old speakers were four in total born between 1938-1949; that is, the age groups are separated by almost 30 years.

3.2.2. Social classification

All the speakers are classified into social classes according to their occupation. In order to do this, it was necessary to devise a set of criteria for ranking individuals.

3.2.2.1. Occupation as a class indicator

Because of the widespread disagreement existing among sociologists with regard to the nature of social class, it is hardly surprising that sociolinguistic surveys have used different methods for determining social class (Macaulay 1977: 57). However, as we will see below, occupation seems always to play an important role in deciding people's social class. Chamber's discussion of the distinction between the blue-collar and white-collar workers is of interest;

> The metaphors about collar colours instantiate a couple of sociological facts about the concept of class: first, social classes are perceived primarily as a function of occupation, hence the conventional workplace attire of white-shirt-and-tie or open-necked blue denim; and, second, one's class is also expressed by certain non-essential traits such as style of dress (going well beyond traditional workclothes) and also manners, recreation, entertainment, and tastes in the broadest sense. (Chambers 1995: 37).

Here we will examine socio-phonetic studies dealing with social classes carried out in the UK. Trudgill (1974) applied in his Norwich study a scoring strategy of a six-component index, in which two of the six components were occupational components (own occupation and father's occupation) and the other four, income, housing, education, and locality.

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[11] M35 and M06 were also father and son.

Macaulay (1976: 173-188) used occupation alone as an indicator of class in Glasgow. He employed the British *Registrar General Social Classes* (RGSC) scheme now renamed *Social Class based on Occupation* (SOC) in 1990 (Occupational Information Unit, Office for National Statistics 2001). As a result, his subjects fell into four occupational groups. Table 1 shows Macaulay's social class categories based on occupation:

Table 1. Macaulay's social class categories based on occupation
(From Macaulay 1976: 174)

Class *I*	Professional and managerial
Class *IIa*	White-collar, intermediate non-manual
Class *IIb*	Skilled manual
Class *III*	Semi-skilled and unskilled manual

According to Chambers (1995: 46), Macaulay's Class I corresponds to MMC (middle middle class), Class IIa and IIb to UWC (upper working class), and Class III to MWC (middle working class) and LWC (lower working class). Macaulay subdivided UWC into manual and non-manual because the non-manual/manual distinction is generally considered one of the most important social class differentiators in a modern industrial society (Goldthorpe, Lockwood, Bechhofer and Platt 1969; Parkin 1971, in Macaulay 1977: 57). Macaulay's reliance on occupation alone as a class indicator turned out to be sufficient; his results clearly showed a regular correlation for all the phonological variables with class (1976: 175-7)

In the study of modern RP, Fabricius (2000) preferred to use a more fine-grained classification of occupations than SOC; she chose the CAMSOC scale, which allocates scores to individual occupations. The Cambridge Scale, as it is called, has been set up by academic researchers at Cambridge University. As Fabricius (2000: 77) cites, Prandy (1992) describes the Cambridge Scale in these terms:

> The Cambridge Scale is a measure of differential advantage as indicated by the tendency of those enjoying similar life-styles to interact socially on the basis of equality. Like social class schemas it uses occupational groups as the basic units that it deals with, but unlike them it does not posit the existence of larger social groupings to which the occupations then have to be allocated… the relation of social interaction (simply derived from information on the occupations of respondents' friends or spouses) is used to determine whether or not a social continuum exists and, if it does, what its nature is, in particular whether it includes any large intervals between occupational groups that might

suggest the existence of class boundaries. The existence of a finely graded hierarchy, rather than a structure of discrete, homogeneous classes, appears to have been borne out by evidence from the application of the scale.

Since her subjects were all university students, Fabricius (2000) used their parents' scores, all of which were above 60, the point which Prandy uses to delimit 'the highest levels of the scale' (Prandy 1992: paragraph 41, cited in Fabricius 2000: 77).

3.2.2.2. Classification of speakers

Now let us return to consider classification of our data. Like Macaulay's, we will rely on occupation alone as a class indicator, while unlike Macaulay's, we will use not only SOC, but also the CAMSIS scale (*CAMSIS: Social Interaction and Stratification Scale*). Table 2 shows the categories of Social Class based on Occupation (SOC):

Table 2. The categories of Social Class based on Occupation (SOC)
(From Occupational Information Unit, Office for National Statistics 2001)

I	Professional, etc. occupations
II	Managerial and Technical occupations
III	Skilled occupations
	(N) non-manual
	(M) manual
IV	Partly skilled occupations
V	Unskilled occupations

If we compare these categories with those of Macaulay (1976) in Table 1, the categories I and II (Professional, managerial and technical occupations) are presumably equivalent to Macaulay's highest social class *I*, the category IIN (skilled non-manual occupations) to Macaulay's *IIa*, the category IIIM (skilled manual occupations) to Macaulay's *IIb*, and the categories IV and V (partly skilled/unskilled occupations) to Macaulay's lowest social class *III*. It was decided here, however, to classify not into four but three social classes, with the lower three categories of SOC being together as the lowest social class. Consequently, in this study, the SOC categories I and II (professional, managerial and technical occupations) are considered as the highest social class, UMC (upper middle class), the category IIIN (skilled non-manual occupations) as LMS (lower middle class), and the categories IIIM, IV, and V (skilled manual, partly skilled/unskilled occupations) as the lowest social class, WC (working class). Similarly, following Fabricius (2000), it was decided that people with an occupation score above 60 in CAMSIS should be regarded as the highest social class, i.e. UMC. However, both classifications do not always match. For example, a job item {Nurses} (SOC-No. 340) is categorised into the category II in SOC, which should be considered as UMC; in CAMSIS, however, {Nurses} is assigned score 52.4 (for male workers), which should be considered LMC. Because of this discrepancy, in this study, each speaker will be classified into one of the following three social classes, *i-iii*, in accordance with the combined criteria of SOC and CAMSIS scores. This combined social classification scheme is tabulated in Table 3 below:

Table 3. Social class divisions based on the combination of SOC & CAMSIS scores

	Social Classes	SOC	CAMSIS scores
i.	UMC: Upper Middle Class	I	(any score)
		II	over 60
ii.	LMC: Lower Middle Class	II	below 60
		IIIN	(any score)
		IIIM	over 60
		IV	over 60
		V	over 60
iii.	WC: Working Class	IIIM	below 60
		IV	below 60
		V	below 60

The score over 60 is regarded as a threshold not only for the highest social class, but also for the upgraded social class. First of all, their own occupations, parent(s)' occupation, and spouse's occupation (if applicable) were all assigned to any one of the occupations on the list of SOC. Classification into social classes is made based on (1) his/her own occupation for older speakers, (2) his/her spouse's occupation if it is ranked higher than their own occupation, or (3) his/her parent's occupation for young speakers. Table 4 provides detailed information about all the speakers' occupation, father's or mother's occupation and their allocated SOC job labels and categories and CAMSIS scores, from which their social class index scores are derived.

Table 4. Speakers' own/spouse's/parent's occupational information and their social classes with SOC categories and CAMSIS scores

Social Class	**Age group**	**ID**	**Self-declared job title**	**SOC-90 Label**	**SOC**	**CAMSIS scores (*male)**
WC	Young	M11	Father: Painter	507 Painters and decorators	IIIM	38.8
		M15	Father: Ambulance man	642 Ambulance Staff	IIIM	46.6
	Old	M25	Own: Ambulance man	642 Ambulance Staff	IIIM	46.6
		M33	Own: London cab driver	874 Taxi, cab drivers and chauffeurs	IIIM	42.3
UMC	Young	M06	Father: Journalist	380 Authors, writers, journalists	II	75.8
		M09	Father: Lawyer	242 Solicitors public	I	85.2
		M12	Father/Mother: Doctors	220 Medical practitioners	I	87.4
	Old	M32	Own: Certified Accountant	250 Chartered and certified accountants	I	72.5
		M35	Own: Technical Journalist	380 Authors, writers, journalists	II	75.8

Recalling the correlation between accent and social class discussed in §2-1, people in a higher social class in London are expected to speak with an RP or at least with London RP, and those in lower social class are likely to speak with a London Regional accent. For this reason, we consider the UMC speakers as London RP speakers, and the WC speakers as London Regional speakers.

3.3. Materials

Three kinds of speech style were elicited from the subjects; this is because stylistic variation often operates along the same scale as social class differences in speech, and also reflects differences in the social context in which a speaker finds him- or herself interacting at a given time, as can be seen in the studies of Labov (1972) and Trudgill (1974). The three kinds of speech style were:

1. interview style (IS),
2. reading-passage style (RPS),
3. word-list style (WLS),

Each session was divided into roughly four sections:

(1) Interview
(2) Reading-passage

(3) Word-list reading
(4) Written-questionnaire

The first Interview section is subdivided further into two parts: a question-and-answer part and a picture-interpretation part. In the former, each speaker was asked questions mainly on personal factual data (birth place, residential history, educational history, parental and family information, etc) and some more general questions. In the latter, each speaker was presented with ten drawings extracted from a picture book called *Where's Wally?* (Handford 1997), and asked to answer a number of questions about each of them. The questions were designed to make it possible to expect to elicit several possible key words containing target sounds. The main purpose in this section was to elicit comparatively a more casual and natural way of speaking.

In the RPS section, each speaker was asked to read a prepared story passage. The passage was prepared by the author to include enough target sounds.

In the WLS section, each speaker was asked to read aloud a prepared list of words in controlled phonological environments where most of them had initial-/t/ or -/h/ with one of DRESS, TRAP and STRUT vowels in primary stressed syllables followed by an alveolar/postalveolar consonant (i.e. /t/, /tʃ/, /d/, /n/, /s/, /ʃ/ and /z/). All the words (including filler words) were embedded in the carrier phrase "Say ____ again". Table 5 shows the target words in the word-list, with the phonological environments.

Table 5. Target words in a word-list with the detail of the phonological environments

Begin with:	**Followed by:**					**No. of tokens**
	/-t/ "/-tʃ/	/-d/	/-n/	/-s/ "/-ʃ/	/-z/ "/-s/	
/ hʌ- /	hut hut	huddle huddle	hunt hunch	hustle huss	husband husband	/ʌ/=10
/ tʌ- /	tut (stutter)	(study) (studhorse)	ton tunnel	tusk tux	tuzzy tuzzy	/ʌ/=10
/ hæ- /	hat "hatch	had haddock	hand handle	hassle hasp	has-been hazard	/æ/=10
/ tæ- /	tat (static)	tad tadpole	tan tantrum tangent	tass tassel	fantasmo phantasma	/æ/=10
/ hɛ- /	hetero heterosex	head ahead	hen hence	hest hest	hesitate hesitant	/ɛ/=10
/ tɛ- /	Tetley tetrapod	teddy bear ted	ten tent	test testy	"testable "testify *tez *tezzy	/ɛ/=10

		Total: /ʌ/=20 /æ/=20 /ɛ/=20

For each vowel, 18~20 tokens in the three different speech styles (IS, RPS and WLS) were selected. It should be noted that the phonological environments in which the selected target vowels occur are restricted; any selected target vowel occurs in a stressed syllable of a content word, but not in a syllable with initial-glide (e.g. 'yet', 'wagon', 'one'), initial consonant clusters of obstruent + liquid (e.g. 'president', 'flat', 'front'), or liquid-final ('tell', 'marry', 'Surrey') to avoid possible coarticulatory effects on the locations of the formants. Due to these restrictions, it was not always possible to find 20 tokens for some vowels of some speakers.

The total number of tokens to be investigated is 1513, calculated by 18~20 tokens for each variable x 3 linguistic variables x 3 speech styles x 9 speakers (Table 6)[12].

Table 6. Design of samples

	Working Class (WC)				Upper Middle Class (UMC)				
	Young (N=2)		Old (N=2)		Young (N=3)			Old (N=2)	
	M11 (age22)	M15 (age25)	M25 (age54)	M33 (age61)	M06 (age20)	M09 (age22)	M12 (age23)	M32 (age59)	M35 (age66)
DRESS in IS/RPS/WLS	20/20/20	20/20/20	20/20/20	20/20/20	20/20/20	18/20/20	20/20/20	20/20/20	20/20/20
TRAP in IS/RPS/WLS	20/20/20	20/20/20	20/20/20	20/20/20	20/20/20	18/20/20	20/20/20	20/20/19	20/20/19
STRUT in IS/RPS/WLS	19/20/20	20/20/20	20/20/20	20/20/20	20/20/20	20/20/20	20/20/20	20/20/20	20/20/20

In the last questionnaire-writing section, speakers were asked to answer a series of questions in order to sort the speakers into various groups. The questionnaire is roughly divided into three sections: (1) personal information, (2) parents' and/or partner's information and (3) language background and attitude. In this study, however, language background and attitude will not be considered.

3.4. Recordings and procedure

A SONY DAT Walkman model no. TCD-D100 was used for the recordings, with a SONY ECM-MS907 microphone and a Sony 60 minute DAT tape.

[12] Although the number of samples should normally be 4-5 for each cell and the samples should ideally include female speakers, the present study only shows the result of 2-3 male speakers who have fallen in one of the categories (i.e. WC-Young, WC-Old, UMC-Young, UMC-Old) in the data analysed so far. However, this investigation is ongoing so that the number is expected to increase and the data from females will be included in due course.

The recordings took place in Leeds and London. In the former case, all the recordings were carried out in a soundproof chamber of the Phonetics Laboratory in the Department of Linguistics & Phonetics of the University of Leeds. (In the latter case, however, such a soundproof equipment was not available.) Nonetheless the main concern had always been that all recordings should take place in as quiet a place as possible. As a result, most of the interviews were conducted in the speakers' own houses or work places, most of which were quiet enough, apart from occasional unavoidable background noise.

3.5. Data Analysis

All the target words were digitised onto the Praat speech analysis programme at a sampling rate of 22kHz[13]. The frequencies of the first and second formants were measured for each vowel at its steady state, close to the middle of the vowel if possible. Values of F1 and F2 were measured with the formant tracker function; however, they were sometimes measured manually when it was necessary.

Following Watt & Fabricius (2002), frequencies in Hz were converted to a mathematically normalised scale, an S-transformed unit, where individual vowel measurements are expressed as ratios of the value of *S* which is calculated using average formant frequencies for the three outer points of a (triangular) vowel space.

3.6. *S-procedure* vowel normalisation

Following Watt & Fabricius (2002), a vowel formant normalisation technique, *S-procedure*, that allows direct visual and statistical comparison of vowel triangles for multiple speakers is applied in this study. All raw formant values are divided by each speaker's 'centre of gravity' *S* value which is the grand mean of F_n for peripheral vowels with which we could derive maximum and minimum F_n values.

S-procedure is evaluated by Watt & Fabricius (2002) alongside linear Hertz measurements and Bark normalised values, and found to be superior in achieving agreement in vowel triangle area and vowel triangle overlap (Watt & Fabricius 2002, Fabricius 2006: 9).

The procedure for determining the F1 and F2 values of *S* for an individual speaker is as follows. Firstly, the average F1 and the average F2 of the most extreme high front vowel should be assumed to represent the lowest F1 and the highest F2, and the average F1 of the most extreme low vowel should be assumed to represent the highest F1 for a given speaker's sample. Secondly, the average F1 and the average F2 of the most extreme high back vowel for a given speaker are supposedly no more than

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[13] The sampling rate, 22kHz, is chosen out of consideration for spectrographic analysis of consonantal variables (T-affricaton, H-dropping).

the average F1 of the most extreme high front vowel, on the assumption that the speaker’s most close and most back possible vowel has an F2 exactly equivalent to its F1 frequency. Watt & Fabricius (2002) choose FLEECE and TRAP vowels, [i] and [a], as the most extreme high front vowel and the most extreme low vowel, and label [uˈ] for the hypothetical most high back vowel, i.e. GOOSE. The schematised representation of the ‘vowel triangle’ on the axes-reversed F1 ~ F2 plane cited from Watt & Fabricius (2002: 164) is recreated below:

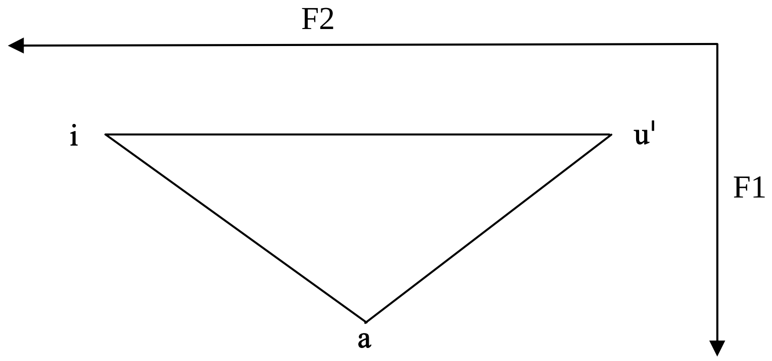


Figure 5. Schematised representation of the ‘vowel triangle’ used for the calculation of *S*. i=min. F1, max. F2 (average F1 ~ F2 for FLEECE); a = max. F1 (average F1 ~ F2 for TRAP); uˈ = min. F1, min. F2, where F1 (uˈ) and F2 (uˈ) = F1(i).

Although they choose these vowels as their peripheral vowels, they also suggest other potential vowels in case that FLEECE and TRAP do not provide a reliable estimate of these limits in a given accent; that is, KIT or FACE as the most extreme high front vowel, and START as the most extreme low vowel (Watt & Fabricius 2002: 163).

In the current study, KIT and START vowels are selected as peripheral vowels for the calculation of *S* on the ground of the nature of the accents in London. The reason that FLEECE and TRAP vowels are not selected here is because a FLEECE vowel is said to be subject to diphthongisation in London speech, while the TRAP vowel is the one in question here that is possibly shifting.

The actual calculation of *S* for the speaker M33 will be shown as an example below in the same manner as demonstrated by Watt & Fabricius (2002: 173). The following are the mean F1, F2, and F2-F1 values for [ɪ ɑ uˈ] from M33’s KIT and START vowels in his WLS data:

Vowel	**F1 (Hz)**	**F2 (Hz)**	**F2-F1 (Hz)**
ɪ	472.6	2221.4	1748.8
ɑ	654.7	1078.2	423.6
uˈ	472.6	472.6	0.0*

[*Theoretical value]

The ground mean values of each of F1, F2 and F2-F1 are calculated for *S* as follows:

$$S(F1) = \frac{472.6 + 654.7 + 472.6}{3} = \frac{1599.9}{3} = 533.3$$

$$S(F2) = \frac{2221.4+1078.2+472.6}{3} = \frac{3772.2}{3} = 1257.4$$

$$S(F2\text{-}F1) = \frac{1748.8 + 423.6 + 0}{3} = \frac{2172.2}{3} = 724.1$$

The KIT, START and GOOSE means in Hz can be converted into *S* units as below:

$$\left.\begin{matrix} 472.6 \\ 654.7 \\ 472.6 \end{matrix}\right\} \div\ 533.3 \qquad \left.\begin{matrix} 2221.4 \\ 1078.2 \\ 472.6 \end{matrix}\right\} \div\ 1257.4 \qquad \left.\begin{matrix} 1748.8 \\ 423.6 \\ 0 \end{matrix}\right\} \div\ 724.1$$

Vowel	**F1/S(F1)**	**F2/S(F2)**	**F2-F1/S(F2-F1)**
ɪ	0.886	1.767	2.415
ɑ	1.228	0.857	0.585
uː	0.886	0.376	0.000

Figures below show M33's vowel triangle as well as those of all the other speakers not only on linear Hz scale (Figure 6) and on S-transformed scale (Figure 8) but also on a Bark scale[14] (Figure 7). It should be noted that, as evaluated by Watt & Fabricius (2002), there is a substantial improvement in the match among the areas both in F1 and F2-F1 dimensions for the different triangles on the S-transformed scale than on linear Hz scale and on Bark scale, especially between M33's and M25's, which are the furthest from each other in both F1 and F2-F1 dimensions on a linear Hz scale.

[14] Following Watt & Fabricius (2002: 162), the raw data in Hz are *z*-transformed using Traunmüller's equation: $z = (26.81 \times f) / (1960 + f) - 0.53$ (Traunmüller 1990).

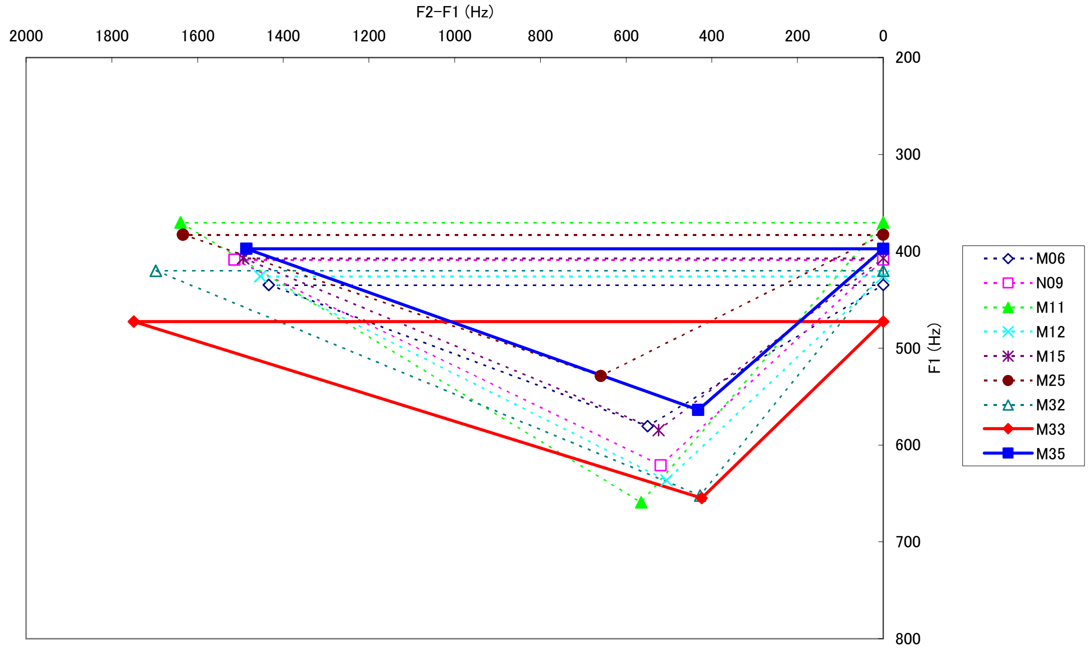


Figure 6. Comparison of KIT ~ START ~ GOOSE vowel triangles for all speakers on linear Hz scale

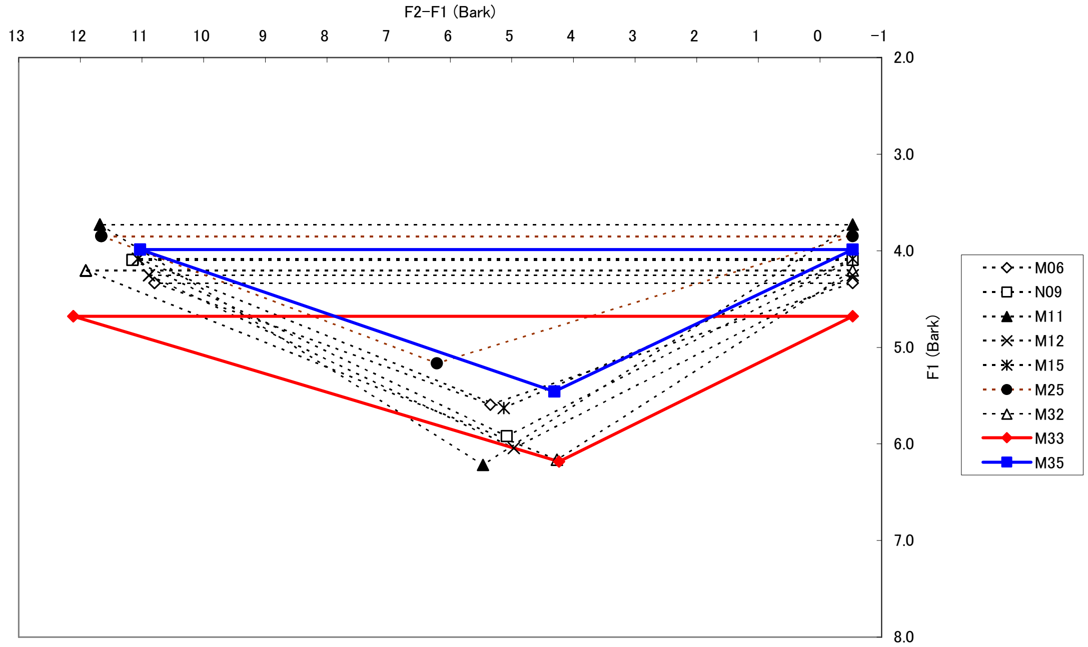


Figure 7. Comparison of KIT ~ START ~ GOOSE vowel triangles for all speakers on Bark scale, using Traunmüller's equation

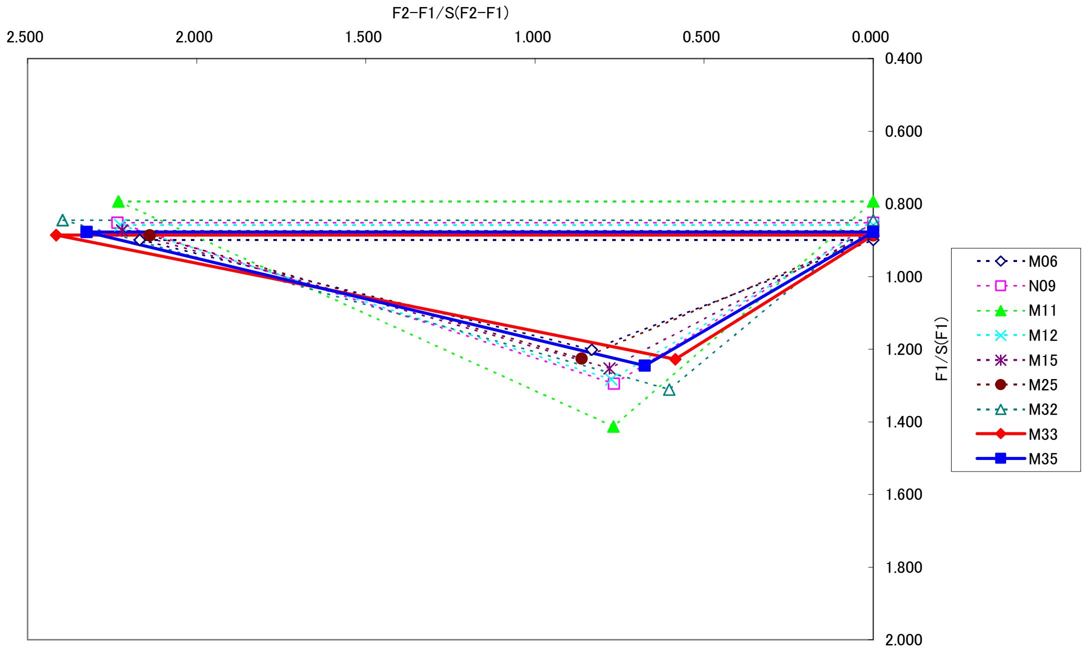


Figure 8. Comparison of KIT ~ START ~ GOOSE vowel triangles for all speakers on S-transformed scale

Thus, all speakers' vowel triangles are defined relative to *S*: we are, therefore, able to directly compare samples for different speakers both statistically and visually (Watt & Fabricius 2002: 165)

4. Results

To examine the significance, a statistical test is carried out. With the *Java Script-Star-version 3.6.9J* (Tanaka 1996), an analysis of variance (ANOVA) is applied separately to each vowel with (1) AGE in each social class: Y-WC vs. O-WC, Y-UMC vs. O-UMC, (2) SOCIAL CLASS in each age group: Y-WC vs. Y-UMC, O-WC vs. O-UMC, and (3) SPEECH STYLE in each age and class group as the single factor. The post-hoc multiple comparisons, Least Significant Difference (LSD) tests, are also applied only if the ANOVA is significant in the case of the comparison among speech styles in each speaker.

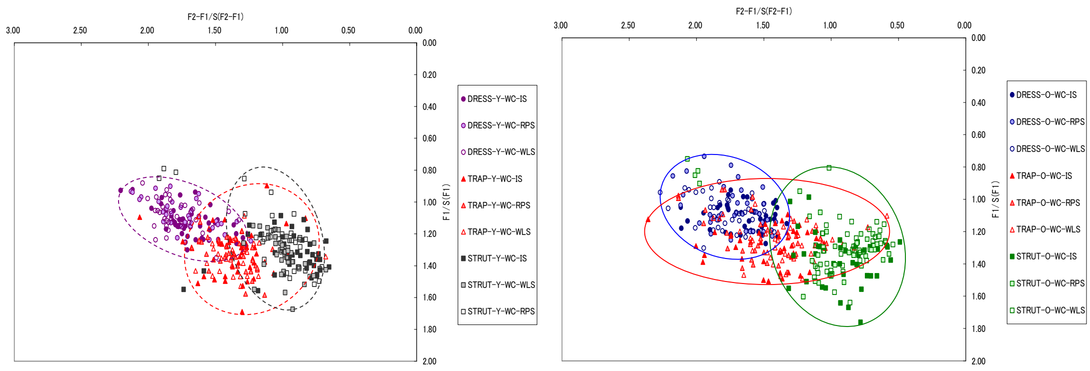
The mean of acoustic measurements (i.e. F1 and F2-F1) are tested for significant differences by ANOVA. In each case the point of interest is whether there is an association between variables. Significance levels will be shown with the marks in Table 7:

Table 7. Significance levels and their marks

P-value (P: probability)	Mark	Significance Level
P> 0.10	ns	Not significant
0.05 < p < 0.10	+	Inclined to be significant
0.01 < p < 0.05	‡	Significant
P<0.01	‡‡	Highly Significant

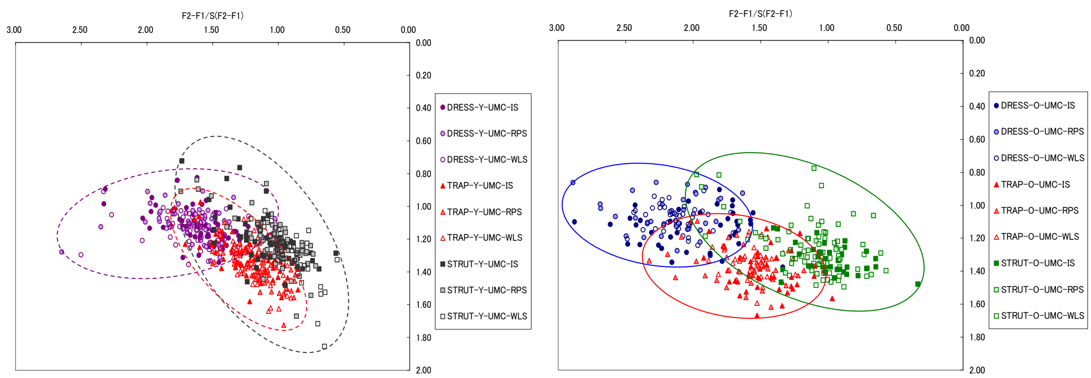
The relative positions of vowels in an individual’s vowel space are presented in traditional plots with F1 (degree of openness) on the Y axis and F2-F1 (degree of frontness) on the X axis (Ladefoged 1993: 197), although all the formant values are expressed in S-transformed values. Comparisons are made (1) between two age groups (Young and Old) for the apparent-time investigation, (2) between two social classes (WC and UMC) and (3) among three different speech styles (IS, RPS and WLS).

Figures below show vowel plots for all the individual tokens on the S-transformed scales, F1/S(F1) on the y-axis, F2-F1/S(F2-F1) on the x-axis, for WC (Figure 9) and for UMC (Figure 10): dotted and bold lines surrounding each vowel represent vowel distributions for young speakers and old speakers, respectively.



(a) Y-WC **(b) O-WC**

Figure 9. Vowel Plots for (a) Y-WC speakers and for (b) O-WC speakers with hand-drawn ellipses



(a) Y-UMC **(b) O-UMC**

Figure 10. Vowel Plots for (a) Y-UMC speakers and for (b) O-UMC speakers with hand-drawn ellipses

All the statistical results are provided in Tables 8 & 9, and so are all the raw data in Tables 10, 11 & 12 in the Appendix.

4.1. Results of age comparison

Age comparison is conducted in each social class: between Y-WC vs. O-WC and between Y-UMC vs. O-UMC.

Figures 11 and 12 show mean frequencies of F1 and F2-F1 for each vowel of each age group in WC (i.e. Y-WC and O-WC) and UMC (i.e. Y-UMC and O-UMC) together with hand-drawn ellipses representing their actual vowel distribution.

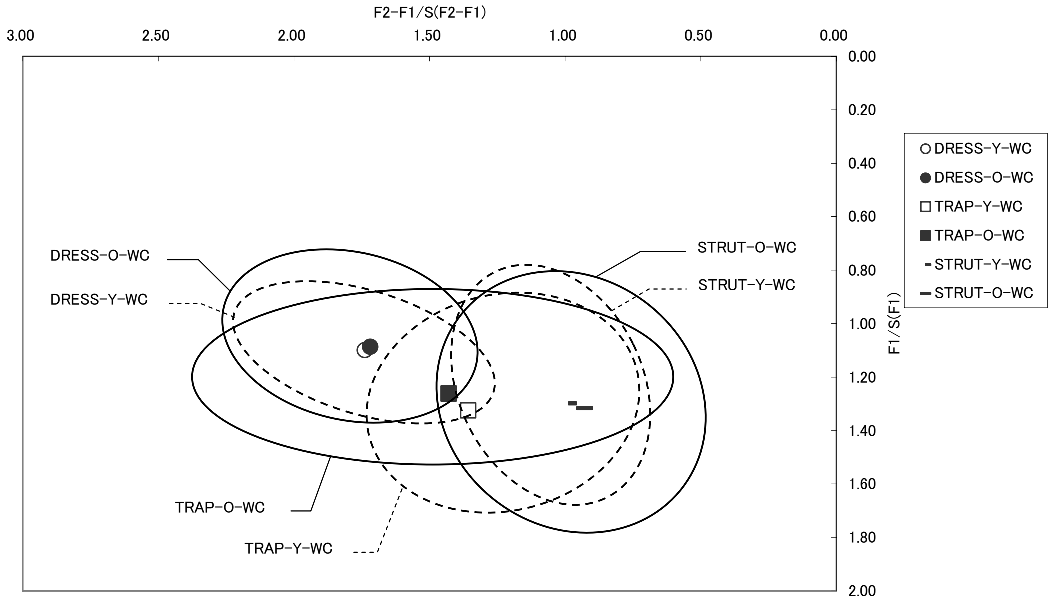


Figure 11. S-transformed mean frequencies of the F1 and F2-F1 for each vowel of each age group in WC speakers (i.e. Y-WC vs. O-WC) with hand-drawn ellipses for their vowel distributions

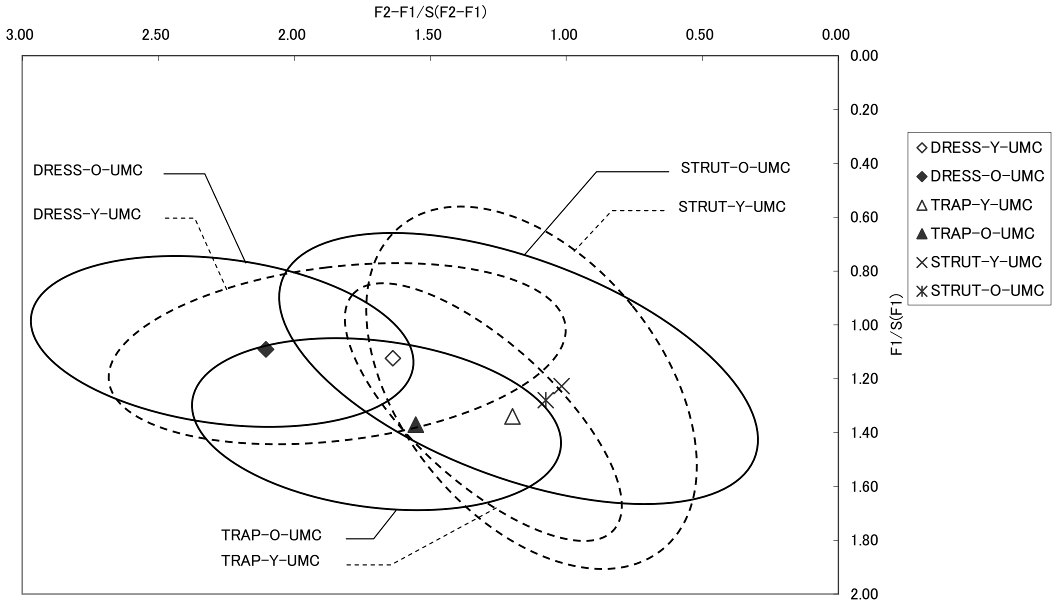


Figure 12. S-transformed mean frequencies of the F1 and F2-F1 for each vowel of each age group in UMC speakers (i.e. Y-UMC vs. O-UMC) with hand-drawn ellipses for their vowel distributions

DRESS in WC shows no movement across age difference both in mean F1 and F2-F1 values, while DRESS in UMC is centring as a combination of backing (i.e. lower mean F2-F1 in Y-UMC, $F(1,295)=210.34$, ‡‡$p<0.01$) and lowering (i.e. higher mean F1 in Y-UMC, $F(1,295)=7.22$, ‡‡$p<0.01$), as in the literature. More peripheral realisations are observed in older speakers' speech, as reported in the literature.

TRAP in WC is backing (i.e. lower mean F2-F1 value in Y-WC, $F(1,238)=5.37$, ‡$p<0.05$) and also lowering (i.e. higher mean F1 in Y-WC, $F(1,238)=16.25$, ‡‡$p<0.01$) to the direction of Y-UMC TRAP or somewhere between Y-UMC and O-UMC. TRAP of Y-WC has a smaller vowel space than that of O-WC. TRAP in UMC is also backing (i.e. lower mean F2-F1 value in Y-UMC, $F(1.294)=216.19$, ‡‡$p<0.01$) as in WC but not lowering. Instead, it is slightly raised to the central (i.e. lower mean F1 in Y-UMC, $F(1,294)=4.51$, +$p<0.10$). It seems the area that UMC TRAP is towards is the similar area that Y-WC TRAP is moving to.

STRUT in WC only shows a slight fronting of this vowel in a way of having a higher mean F2-F1 in Y-WC (cf. $F(1,287=3.24)$, +$p<0.10$). STRUT in UMC, on the other hand, indicates the vowel is backing (i.e. lower mean F2-F1 in Y-UMC, $F(1,298)=4.42$, ‡$p<0.05$) and being more close (i.e. lower mean F1 in Y-UMC, $F(1,298)=8.98$, ‡‡$p<0.01$).

4.2. Results of social class comparison

Social class comparison is conducted in each age group: between Y-WC vs. Y-UMC and between O-WC vs. O-UMC.

Figures 13 and 14 show mean frequencies of F1 and F2-F1 for each vowel of each social class group in Young speakers (i.e. Y-WC and Y-UMC) and in Old speakers (i.e. O-WC and O-UMC) together with hand-drawn ellipses representing their actual vowel distribution.

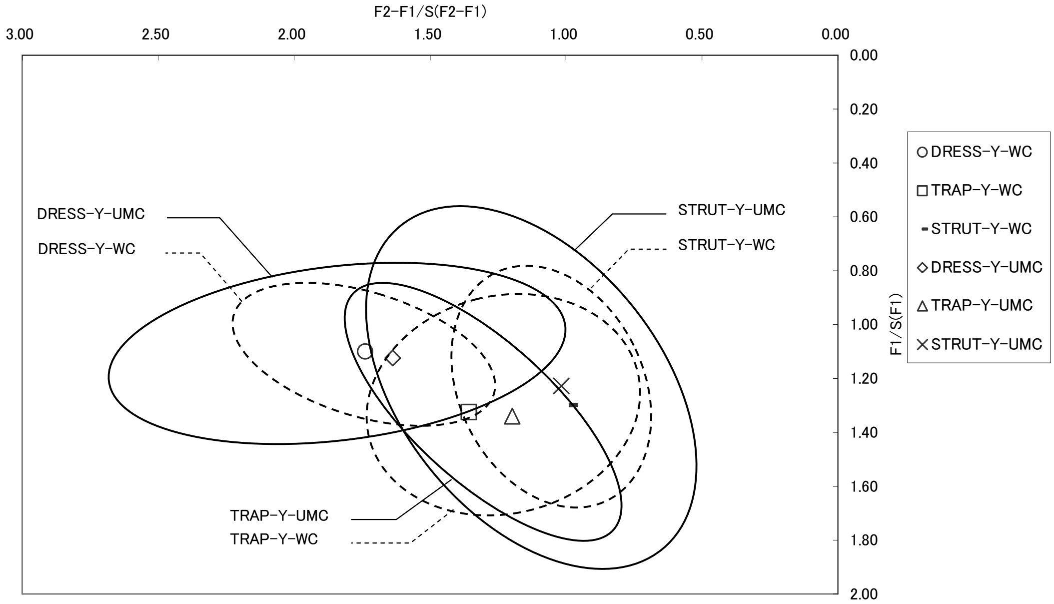


Figure 13. S-transformed mean frequencies of the F1 and F2-F1 for each vowel of each age group in Young speakers (i.e. Y-WC vs. Y-UMC) with hand-drawn ellipses for their vowel distributions

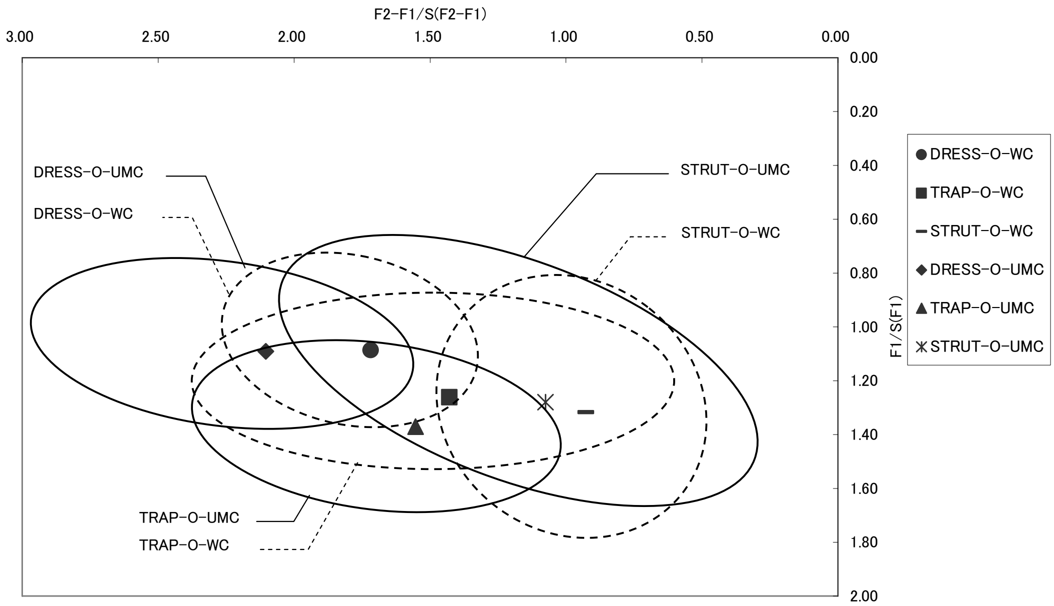


Figure 14. S-transformed mean frequencies of the F1 and F2-F1 for each vowel of each age group in Old speakers (i.e. O-WC vs. O-UMC) with hand-drawn ellipses for their vowel distributions

DRESS in WC has a more convergent vowel space in terms of vowel front-/backness regardless of age; it is somewhere in the middle of UMC's vowel space, which is behind the more peripheral type of O-UMC's DRESS (c.f. lower mean F2-F1 value in O-WC, $F(1,238)=125.18$, ‡‡$p=0.01$) and closer front from the more centralised type of Y-UMC's (c.f. lower mean F1 value in Y-WC, $F(1,295)=4.24$, ‡$p<0.05$; higher mean F2-F1 value in Y-WC, $F(1,295)=15.47$, ‡‡$p<0.01$).

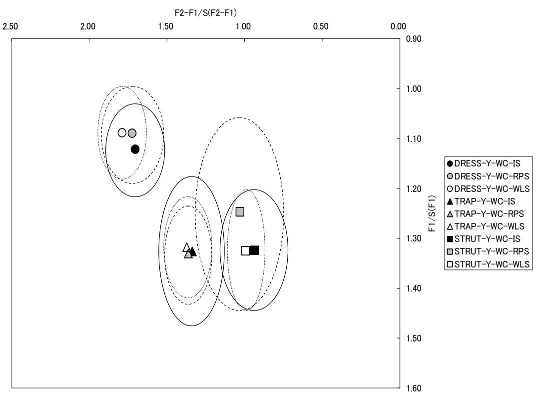
TRAP in Y-WC shows more front realisations (c.f. higher mean F2-F1 value in Y-WC, $F(1,296)=56.84$, ‡‡$p<0.01$) than Y-UMC which has slightly retracted realisations fairly overlapped with their STRUT vowels. O-WC's TRAP is more centralised (i.e. lower F1 and lower F2-F1), while O-UMC's is more peripheral (i.e. higher F1 and higher F2-F1) as a more open type of realisation along with the current-RP tendency of this vowel (c.f. lower mean F1 value in O-WC, $F(1,236)=50.39$, ‡‡$p<0.01$; lower mean F2-F1 value in O-WC, $F(1,236)=13.25$, ‡‡$p<0.01$).

STRUT in WC shows a more retracted type of realisation than UMC in both age groups. Y-WC has a more open type of realisation (i.e. higher mean F1 value, $F(1,297)=15.66$, ‡‡$p<0.01$) than Y-UMC, while O-WC has more back, slightly lowered realisations (i.e. lower mean F2-F1 value, $F(1,238)=17.01$, ‡‡$p<0.01$; higher mean F1 value, $F(1,238)=3.35$, +$p<0.10$) than O-UMC.

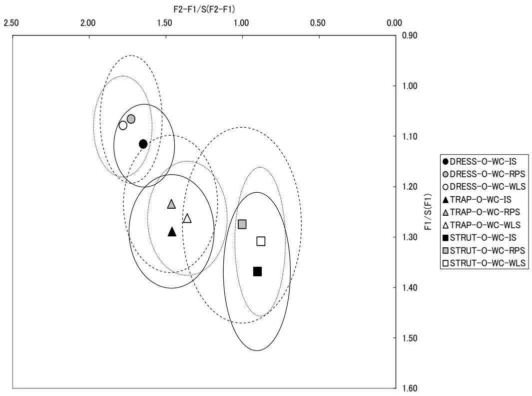
4.3. Results of speech style comparison

Speech style comparison is conducted in each age and social class group, comparing IS vs. RPS vs. WLS in YWC, OWC, YUMC, and OUMC.

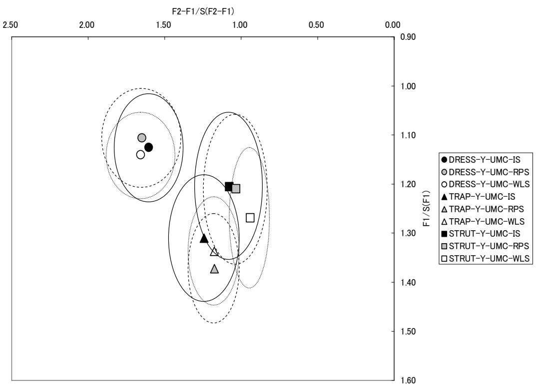
Figure 15 shows mean values and their Standard Deveations (SDs) for each vowel in each age and social class group, i.e. Y-WC, O-WC, Y-UMC, and O-UMC.



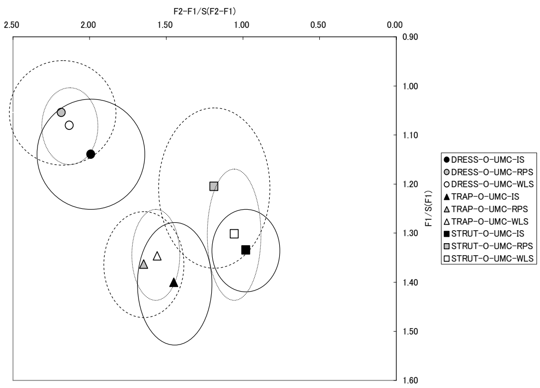
(a) Y-WC



(b) O-WC



(c) Y-UMC



(d) O-UMC

Figure 15. S-transformed mean frequencies for each vowel in IS, RPS and WLS among (a) Y-WC, (b) O-WC, (c) Y-UMC and (d) O-UMC with lines for S.D. (Standard Deviation): bold lines for IS, dotted lines for RPS, and thin lines for WLS

Young speakers seem to constantly have centralised realisations for the DRESS vowel; that is, no significant difference among mean F1 and F2-F1 values in three different speech styles for this vowel for Y-WC and Y-UMC. Old speakers, however, tend to have significantly more centralised realisations for this vowel in the more casual style (i.e. IS) and more peripheral (i.e. close and front) realisations in more formal styles (i.e. RPS and WLS). (c.f. higher mean F1 value for O-WC-IS, F(2,117)=2.42, +p<0.10, ‡IS>RPS by LSD; higher mean F1 value for O-UMC-IS, F(2,117)=7.59, ‡‡p<0.01, ‡IS>RPS, ‡IS>WLS by LSD).

WC speakers do not show statistically significant stylistic differences for the TRAP vowel. UMC speakers show different stylistic variation between the young and the old; Y-UMC has significantly more advanced and closer realisations in more casual speech (i.e. higher mean F2-F1 value for Y-UMC-IS, F(2,175)=2.79, +p<0.10, ‡IS>RPS, ‡IS>WLS by LSD ; lower mean F1 value for Y-UMC-IS, F(2,175)=4.00, ‡p<0.05, ‡IS<RPS by LSD), while O-UMC has realisations which are significantly

more retracted and more open in more casual speech (i.e. lower mean F2-F1 value for O-UMC-IS, F(2,115)=7.73, ‡‡p<0.01, ‡IS<RPS, ‡IS<WLS by LSD; higher mean F1 value for O-UMC-IS, F(2,115)=2.44, +p<0.10, ‡IS>WLS by LSD).

WC speakers show statistically more open realisations (i.e. higher F1) in IS than RPS for the STRUT vowel; in case of Y-WC speakers, they have even more of this open realisation in WLS than RPS (c.f. higher mean F1 values for Y-WC-IS/WLS, F(2,116)=3.62, ‡p<0.05, ‡IS>RPS, ‡RPS<WLS by LSD; higher mean F1 value for O-WC, F(2,117)=3.21, ‡p<0.05, ‡IS>RPS by LSD). Y-UMC speakers have closer realisations in more casual styles (i.e. IS and RPS) (c.f. lower mean F1 values for Y-UMC-IS/RPS, F(2,177)=3.42, ‡p<0.05, ‡IS<WLS, ‡RPS<WLS by LSD). O-UMC speakers have closer and advanced realisations in RPS, but more open and retracted realisations in IS (i.e. lower mean F1 value for O-UMC-RPS but higher mean F1 value for O-UMC-IS, F(2,117)=10.30, ‡‡p<0.01, ‡IS>RPS, ‡RPS<WLS by LSD; higher mean F2-F1 value for O-UMC-RPS but lower mean F2-F1 value for O-UMC-IS, F(2,117)=6.34, ‡‡p<0.01, ‡IS<RPS, ‡RPS>WLS by LSD).

5. Conclusions and future research

Different types of vowel shifts in different directions are found in WC (i.e. London Regional speakers) and UMC (i.e. London RP speakers). The directions found from age comparison in each social class are shown in Figure 16.

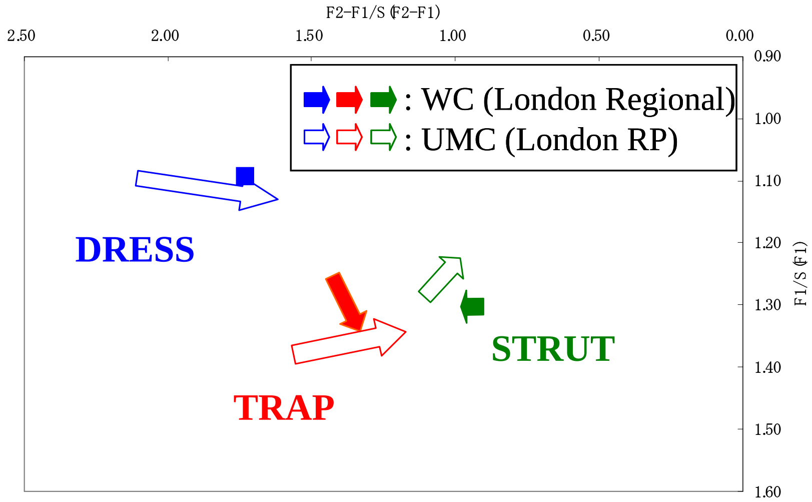


Figure 16. Short vowels – DRESS, TRAP, STRUT – changes in this study

In case of DRESS vowels, age and social class comparisons reveal that this vowel is apparently centring in UMC, while WC has more retracted realisations in a smaller vowel space than UMC without any apparent shifting between the old and the young. Speech style comparison, showing that in more formal styles older speakers seem to avoid using centralised variants which are constantly used by the young speakers, may suggest these centralised realisations should be associated with a certain degree of stigma while peripheral ones should be associated with old-fashioned, possibly more RP-type of speech.

Age comparison shows that the TRAP vowel is apparently backing both in WC and UMC converging to the similar vowel space; UMC is backing further from an open front position while WC is backing to the less extent from a less open, slightly centralised position. This may suggest that peripheral realisations are associated with older speakers. Younger speakers have a smaller vowel space than older speakers. Social class comparison could be a support for the idea of Wells (1982a: 129) that the UMC's more open realisation may possibly be a reaction to the WC's closer Cockney type of realisations. O-WC's closer realisations for this vowel overlapping with their DRESS may cause confusion with their DRESS, while Y-UMC's lower and retracted realisations of this vowel possibly cause confusion with their STRUT vowel as Wells (1982b: 292) mentions. Style comparison does not show a clear indication for the stigma/prestige for this vowel; open and retracted variants are preferred by O-UMC and slightly front and closer realisations by Y-UMC in more casual IS speech.

As for the STRUT vowel, social class comparison, contrary to previous literature, suggests that a more retracted realisation for this vowel is associated with WC speech in this study. When the tendency within each class is observed against age, however, this vowel is slightly fronting in WC, and backing and rising in UMC; the latter may possibly be a result of a fairly retracted TRAP realisation to avoid confusion between TRAP and STRUT, although there is no evidence for whether this change is due to a push-chain shift or a drag-chain shift. Style comparison does not give a clear idea for the social evaluation of this vowel.

This study is only a preliminary result for possible movement of the DRESS, TRAP and STRUT vowels in the London area. Further investigation should be carried out with a larger sample of speakers of different social backgrounds; gender and area of London should also be included as variables. Auditory analysis should also be conducted in due course. However, for the time being, it is hoped that this preliminary spectrographic study of the DRESS, TRAP and STRUT vowels in London English will at least give a tentative picture of the current situation.

Acknowledgement

I wish to thank my supervisor, Dr. Barry Heselwood, at the Department of Linguistics & Phonetics of the University of Leeds, for his valuable comments on earlier drafts of this paper and his dedicated supervision to my PhD work on which this work is based. I am also very grateful to two reviewers for their valuable criticisms and advice. Responsibility for any remaining errors is my own. I would like to record my appreciation to the Rotary International and the School of Modern Languages and Cultures in the University of Leeds for their financial support for my PhD work.

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Miho Kamata
Department of Linguistics & Phonetics
University of Leeds
LS2 9JT

lnp2mk@leeds.ac.uk

Appendix

Tables 8 - 9:

The results of ANOVAs and post-hoc LSD test applied separately to each vowel. The post-hoc tests are applied only if the ANOVA is significant in the style comparison. Column1: vowel type. Column2: Social groups. Column3: Speech Style. Column4: Number of samples. Column5: mean F1 values (Table 8) and mean F2-F1 values (Table 9) in Hz. Column6: Standard Deviation (SD) in Hz. Column7: S-transformed F1 values (Table 8) and F2-F1 values (Table 9). Column8: SDs for S-transformed formant values of F1 (Table 8) and F2-F1 (Table 9). Column9: the results of the ANOVA for speech style comparison. Column10: post-hoc LSD tests comparing IS with RPS, IS with WLS and RPS with WLS only if the ANOVA shows their differences are significant. Column11: Number of samples for each vowel of each social group. Column12-13: mean F1 values and their SDs in Hz (Table 8) and mean F2-F1 values and their SDs (Table 9) for each vowel of each social group. Column14-15: S-transformed F1 values and their SDs (Table 8) and F2-F1 values and their SDs (Table 9) for each vowel of each social group. Column16: the results of the ANOVA for age and social class comparisons. All the results for the ANOVA are shown with the F-ratio and degree of freedom (df). (**, P<.01; *, p<.05; +, p<.10; ns, non-significant).

Tables 10-12:

Mean values for DRESS (Table 10), TRAP (Table 11), and STRUT (Table 12) of all speakers subcategorised according to their speech style, social age and social class groups. Column1: vowel type. Column2: social groups. Column3: speaker ID. Column4: speech style. Column5: number of tokens. Column6: S-values for F1/F2/F2-F1. Column7: mean values in Hz for F1/F2/F2-F1. Column8: SD in Hz for F1/F2/F2-F1. Column9: S-transformed mean values for F1/F2/F2-F1. Column10: S-tranformed SD for F1/F2/F2-F1.

Table 8. *F1 (Statistics: ANOVA and Post-hoc LSD tests)*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Vowel	Grp	Style	N	mean F1(Hz)	SD (Hz)	mean F1/S(F1)	SD/S (F1)	ANOVA (Style Comparison)	Post-hoc LSD tests (Style Comparison)	Grp N	Grp mean F1 (Hz)	Grp SD (Hz)	Grp mean F1/S(F1)	Grp SD/S (F1)	ANOVA (Age / Social Class Comparisons)			
															x YWC	x OWC	x YUMC	x OUMC
DRESS	YWC	IS	40	523	44	1.12	0.10	ns, F(2,117)=1.57		120	513	45	1.10	0.10		ns, F(1,238)=0.99	*, F(1, 295)=4.24	
		RPS	40	508	46	1.09	0.10											
		WLS	40	508	43	1.09	0.09											
	OWC	IS	40	537	58	1.12	0.08	+, F(2,117)=2.42	*: IS>RPS	120	522	58	1.09	0.11				ns, F(1,238)=0.10
		RPS	40	513	72	1.07	0.13		ns: IS=WLS									
		WLS	40	517	39	1.08	0.10		ns: RPS=WLS									
	YUMC	IS	58	547	51	1.13	0.11	ns, F(2,174)=1.78		178	546	47	1.12	0.10				P, F(1,295)=7.22
		RPS	60	538	47	1.11	0.10											
		WLS	60	554	40	1.14	0.09											
	OUMC	IS	40	540	47	1.14	0.11	**, F(2, 117)=7.59	*: IS>RPS	120	518	50	1.09	0.11				
		RPS	40	500	47	1.05	0.11		*: IS> WLS									
		WLS	40	514	48	1.08	0.08		ns: RPS=WLS									
TRAP	YWC	IS	40	618	71	1.33	0.15	ns, F(2,117)=0.11		120	618	56	1.32	0.12		**, F(1,238)=16.25	ns, F(1,296)=1.15	
		RPS	40	620	47	1.33	0.10											
		WLS	40	615	48	1.32	0.10											
	OWC	IS	40	619	60	1.29	0.11	ns, F(2,117)=2.03		120	607	70	1.26	0.12				**, F(1,236)=50.39
		RPS	40	595	85	1.23	0.14											
		WLS	40	606	63	1.26	0.11											
	YUMC	IS	58	637	62	1.31	0.13	*, F(2,175)=4.00	*: IS<RPS	178	652	61	1.34	0.12				*, F(1,294)=4.51
		RPS	60	668	58	1.37	0.11		ns: IS=WLS									
		WLS	60	650	62	1.34	0.12		ns: RPS=WLS									
	OUMC	IS	40	664	55	1.40	0.13	+, F(2,115)=2.44	ns: IS=RPS	118	650	54	1.37	0.11				
		RPS	40	646	40	1.36	0.11		*: IS>WLS									
		WLS	38	640	62	1.35	0.09		ns: RPS=WLS									
STRUT	YWC	IS	39	617	56	1.32	0.12	*, F(2,116)=3.62	*: IS>WLS	119	606	71	1.30	0.15		ns, F(1,237)=0.79	**, F(1,297)=15.66	
		RPS	40	582	90	1.25	0.19		ns: IS=WLS									
		WLS	40	618	56	1.33	0.12		*: RPS<WLS									
	OWC	IS	40	659	90	1.37	0.16	*, F(2,117)=3.21	*: IS>RPS	120	633	91	1.32	0.17				+, F(1,238)=3.35
		RPS	40	613	102	1.27	0.19		ns: IS=WLS									
		WLS	40	628	73	1.31	0.15		ns: RPS=WLS									
	YUMC	IS	60	586	74	1.21	0.15	*, F(2,177)=3.42	ns: IS=RPS	180	597	77	1.23	0.15				**, F(1,298)=8.98
		RPS	60	589	79	1.21	0.15		*: IS<WLS									
		WLS	60	617	74	1.27	0.14		*: RPS<WLS									
	OUMC	IS	40	634	51	1.33	0.08	**, F(2,117)=10.30	*: IS>RPS	120	609	81	1.28	0.14				
		RPS	40	573	91	1.20	0.17		ns: IS=WLS									
		WLS	40	620	85	1.30	0.14		*: RPS<WLS									

Table 9. *F2-F1 (Statistics: ANOVA and Post-hoc LSD tests)*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Vowel	Grp	Style	N	mean F2-F1 Hz)	SD (Hz)	mean F2-F1/S(F2-F1)	SD/S (F2-F 1)	ANOVA (Style Comparison)	Post-hoc LSD tests (Style Comparison)	Grp N	Grp mean F2-F1 (Hz)	Grp SD (Hz)	Grp mean F2-F1/S(F 2-F1)	Grp SD/S (F2-F1)	ANOVA (Age / Social Class Comparisons)			
															x YWC	x OWC	x YUMC	x OUMC
DRESS	YWC	IS	40	1202	168	1.70	0.19	ns, F(2,117)=2.27		120	1226	164	1.74	0.19		ns, F(1,238)=0.67	**, F(1,295)=15.47	
		RPS	40	1216	180	1.72	0.21											
		WLS	40	1261	139	1.79	0.15											
	OWC	IS	40	1227	163	1.65	0.20	*, F(2,117)=4.43	ns: IS=RPS	120	1279	157	1.72	0.21				**, F(1,238)=125.18
		RPS	40	1286	155	1.73	0.20		*: IS<WLS									
		WLS	40	1323	140	1.78	0.20		ns. RPS=WLS									
	YUMC	IS	58	1065	149	1.60	0.23	ns, F(2.174)=0.82		178	1087	156	1.64	0.24				**, F(1,295)=210.34
		RPS	60	1095	167	1.65	0.26											
		WLS	60	1100	150	1.66	0.23											
	OUMC	IS	40	1225	156	1.99	0.35	*, F(2, 117)=4.16	*: IS<RPS	120	1299	177	2.10	0.32				
		RPS	40	1350	200	2.18	0.36		*: IS<WLS									
		WLS	40	1322	150	2.13	0.18		ns: RPS=WLS									
TRAP	YWC	IS	40	940	148	1.34	0.21	ns, F(2,117)=0.40		120	954	127	1.36	0.18		*, F(1,238)=5.37	**, F(1,296)=56.84	
		RPS	40	958	110	1.36	0.16											
		WLS	40	965	122	1.37	0.17											
	OWC	IS	40	1090	229	1.46	0.28	ns, F(2,117)=1.69		120	1066	229	1.43	0.29				**, F(1,236)=13.25
		RPS	40	1093	249	1.46	0.31											
		WLS	40	1014	203	1.36	0.26											
	YUMC	IS	58	824	150	1.24	0.23	+, F(2,175)=2.79	*: IS>RPS	178	795	117	1.20	0.18				**, F(1,294)=216.19
		RPS	60	780	110	1.17	0.17		*: IS>WLS									
		WLS	60	781	78	1.18	0.12		ns: RPS=WLS									
	OUMC	IS	40	900	164	1.45	0.24	**, F(2,115)=7.73	*: IS<RPS	118	965	176	1.55	0.24				
		RPS	40	1023	184	1.65	0.26		*: IS<WLS									
		WLS	38	973	160	1.56	0.16		ns: RPS=WLS									
STRUT	YWC	IS	39	657	167	0.94	0.23	ns, F(2,116)=1.76		119	693	160	0.99	0.22		+, F(1,237)=324	ns, F(1,297)=1.50	
		RPS	40	724	205	1.03	0.28											
		WLS	40	698	76	0.99	0.12											
	OWC	IS	40	675	180	0.90	0.22	ns, F(2,117)=2.22		120	693	218	0.93	0.28				**, F(1,238)=17.01
		RPS	40	749	296	1.00	0.39											
		WLS	40	657	140	0.88	0.17											
	YUMC	IS	60	715	146	1.08	0.22	**, F(2,177)=7.73	ns: IS=RPS	180	676	135	1.02	0.20				*, F(1,298)=4.42
		RPS	60	687	145	1.03	0.22		*: IS>WLS									
		WLS	60	625	94	0.94	0.14		*: RPS>WLS									
	OUMC	IS	40	611	162	0.98	0.22	**, F(2,117)=6.34	*: IS<RPS	120	666	178	1.08	0.27				
		RPS	40	733	220	1.19	0.36		ns: IS=WLS									
		WLS	40	655	118	1.06	0.17		*: RPS>WLS									

Table 10. DRESS: Raw Data

					F1					F2					F2-F1				
1	2	3	4	5	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10
Vowel	Grp	ID	Style	N	S(F1)	mean	SD	mean	SD/S(F1)	S(F2)	mean	SD	mean	SD/S(F2)	S(F2-F1)	mean	SD	mean	SD/S(F2-F1)
DRESS	YWC	M11	IS	20	466.4	509	48	1.09	0.10	1201.0	1825	106	1.52	0.09	734.8	1316	120	1.79	0.16
			RPS	20		480	42	1.03	0.09		1826	111	1.52	0.09		1346	127	1.83	0.17
			WLS	20		501	42	1.07	0.09		1862	65	1.55	0.05		1361	63	1.85	0.09
		M15	IS	20	466.3	537	36	1.15	0.08	1139.0	1625	112	1.43	0.10	672.6	1088	127	1.62	0.19
			RPS	20		536	31	1.15	0.07		1620	112	1.42	0.10		1087	122	1.62	0.18
			WLS	20		514	44	1.10	0.09		1674	114	1.47	0.10		1160	120	1.72	0.18
	OWC	M25	IS	20	431.4	493	35	1.14	0.08	1195.7	1793	164	1.50	0.14	764.4	1300	173	1.70	0.23
			RPS	20		471	65	1.09	0.15		1797	147	1.50	0.12		1326	160	1.73	0.21
			WLS	20		496	32	1.15	0.07		1813	133	1.52	0.11		1316	129	1.72	0.17
		M33	IS	20	533.3	581	39	1.09	0.07	1257.4	1735	123	1.38	0.10	724.1	1155	117	1.59	0.16
			RPS	20		554	54	1.04	0.10		1800	132	1.43	0.10		1246	142	1.72	0.20
			WLS	20		537	34	1.01	0.06		1867	140	1.48	0.11		1330	152	1.84	0.21
	YUMC	M06	IS	20	483.1	563	57	1.17	0.12	1144.5	1629	127	1.42	0.11	661.4	1066	154	1.61	0.23
			RPS	20		545	64	1.13	0.13		1671	225	1.46	0.20		1126	226	1.70	0.34
			WLS	20		554	51	1.09	0.11		1641	231	1.36	0.20		1087	234	1.56	0.35
		M09	IS	18	479.5	550	28	1.15	0.06	1157.0	1609	120	1.39	0.10	677.5	1059	139	1.56	0.20
			RPS	20		534	42	1.11	0.09		1588	145	1.37	0.13		1054	150	1.56	0.22
			WLS	20		568	38	1.18	0.08		1675	110	1.45	0.10		1108	107	1.63	0.16
		M12	IS	20	496.0	528	58	1.06	0.12	1149.1	1596	142	1.39	0.12	653.1	1068	159	1.64	0.24
			RPS	20		534	30	1.08	0.06		1637	98	1.42	0.09		1104	103	1.69	0.16
			WLS	20		540	22	1.09	0.04		1646	68	1.43	0.06		1106	71	1.69	0.11
	OUMC	M32	IS	20	497.6	539	49	1.08	0.10	1221.6	1793	120	1.47	0.10	708.2	1254	121	1.77	0.17
			RPS	20		505	54	1.02	0.11		1936	135	1.58	0.11		1431	127	2.02	0.18
			WLS	20		543	43	1.09	0.09		1980	114	1.62	0.09		1437	112	2.03	0.16
		M35	IS	20	452.8	542	45	1.20	0.10	1091.8	1737	158	1.59	0.14	639.0	1196	184	1.87	0.29
			RPS	20		495	40	1.09	0.09		1763	216	1.62	0.20		1269	229	1.99	0.36
			WLS	20		484	32	1.07	0.07		1692	86	1.55	0.08		1208	77	1.89	0.12

Table 11. TRAP: Raw Data

					F1					F2					F2-F1				
1	2	3	4	5	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10
Vowel	Grp	ID	Style	N	S(F1)	mean	SD	mean	SD/S(F1)	S(F2)	mean	SD	mean	SD/S(F2)	S(F2-F1)	mean	SD	mean	SD/S(F2-F1)
TRAP	YWC	M11	IS	20	466.4	630	82	1.35	0.17	1201.0	1588	172	1.32	0.14	734.8	958	128	1.30	0.17
			RPS	20		635	49	1.36	0.10		1617	72	1.35	0.06		982	97	1.34	0.13
			WLS	20		644	36	1.38	0.11		1638	133	1.36	0.07		994	133	1.35	0.11
		M15	IS	20	466.3	607	58	1.30	0.12	1139.0	1528	167	1.34	0.15	672.6	921	166	1.37	0.25
			RPS	20		606	40	1.30	0.09		1539	108	1.35	0.10		933	119	1.39	0.18
			WLS	20		585	39	1.26	0.09		1521	116	1.34	0.07		936	105	1.39	0.11
	OWC	M25	IS	20	431.4	580	52	1.34	0.12	1195.7	1810	209	1.51	0.17	764.4	1230	237	1.61	0.31
			RPS	20		537	77	1.24	0.18		1794	127	1.50	0.11		1258	175	1.65	0.23
			WLS	20		566	49	1.31	0.18		1648	190	1.38	0.07		1082	198	1.42	0.08
		M33	IS	20	533.3	658	38	1.23	0.07	1257.4	1609	110	1.28	0.09	724.1	951	101	1.31	0.14
			RPS	20		653	44	1.22	0.08		1582	180	1.26	0.14		929	200	1.28	0.28
			WLS	20		647	49	1.21	0.08		1593	195	1.27	0.08		946	189	1.31	0.11
	YUMC	M06	IS	20	483.1	610	82	1.26	0.17	1144.5	1545	90	1.35	0.08	661.4	935	139	1.41	0.21
			RPS	20		626	47	1.30	0.10		1465	44	1.28	0.04		838	64	1.27	0.10
			WLS	20		622	53	1.29	0.09		1411	77	1.23	0.06		789	75	1.19	0.14
		M09	IS	18	479.5	653	43	1.36	0.09	1157.0	1421	96	1.23	0.08	677.5	691	124	1.13	0.18
			RPS	20		667	39	1.39	0.08		1420	79	1.23	0.07		753	106	1.11	0.16
			WLS	20		649	61	1.35	0.10		1424	74	1.23	0.05		775	88	1.14	0.13
		M12	IS	20	496.0	651	45	1.31	0.09	1149.1	1414	91	1.23	0.08	653.1	764	122	1.17	0.19
			RPS	20		710	54	1.43	0.11		1451	90	1.26	0.08		748	128	1.15	0.20
			WLS	20		680	58	1.37	0.19		1458	70	1.27	0.05		778	75	1.19	0.13
	OUMC	M32	IS	20	497.6	672	50	1.35	0.10	1221.6	1654	145	1.35	0.12	708.2	983	149	1.39	0.21
			RPS	20		645	43	1.30	0.09		1769	127	1.45	0.10		1123	158	1.59	0.22
			WLS	19		689	34	1.38	0.08		1736	106	1.42	0.10		1047	114	1.48	0.18
		M35	IS	20	452.8	657	61	1.45	0.13	1091.8	1475	118	1.35	0.11	639.0	818	138	1.28	0.22
			RPS	20		647	39	1.43	0.09		1570	136	1.44	0.12		923	153	1.44	0.24
			WLS	19		592	46	1.31	0.10		1419	97	1.30	0.09		827	82	1.29	0.13

Table 12. STRUT: Raw Data

					F1					F2					F2-F1				
1	2	3	4	5	6	7	8	9	10	6	7	8	9	10	6	7	8	9	10
Vowel	Grp	ID	Style	N	S(F1)	mean	SD	mean	SD/S(F1)	S(F2)	mean	SD	mean	SD/S(F2)	S(F2-F1)	mean	SD	mean	SD/S(F2-F1)
STRUT	YWC	M11	IS	19	466.4	646	51	1.39	0.11	1201.0	1320	244	1.10	0.20	734.8	674	217	0.92	0.30
			RPS	20		584	110	1.25	0.24		1345	148	1.12	0.12		761	229	1.04	0.31
			WLS	20		649	50	1.39	0.11		1334	88	1.11	0.07		685	81	0.93	0.11
		M15	IS	20	466.3	590	48	1.27	0.10	1139.0	1232	88	1.08	0.08	672.6	642	101	0.95	0.15
			RPS	20		579	66	1.24	0.14		1267	129	1.11	0.11		688	175	1.02	0.26
			WLS	20		587	44	1.26	0.09		1298	81	1.14	0.07		710	71	1.06	0.11
	OWC	M25	IS	20	431.4	602	90	1.39	0.21	1195.7	1413	111	1.18	0.09	764.4	811	133	1.06	0.17
			RPS	20		563	98	1.31	0.23		1438	182	1.20	0.15		875	240	1.15	0.31
			WLS	20		589	77	1.36	0.18		1364	88	1.14	0.07		775	63	1.01	0.08
		M33	IS	20	533.3	716	39	1.34	0.07	1257.4	1254	113	1.00	0.09	724.1	538	99	0.74	0.14
			RPS	20		664	81	1.24	0.15		1286	225	1.02	0.18		622	298	0.86	0.41
			WLS	20		668	43	1.25	0.08		1207	95	0.96	0.08		539	83	0.74	0.11
	YUMC	M06	IS	20	483.1	552	106	1.14	0.22	1144.5	1359	122	1.19	0.11	661.4	807	144	1.22	0.22
			RPS	20		549	68	1.14	0.14		1325	113	1.16	0.10		775	149	1.17	0.23
			WLS	20		578	45	1.20	0.09		1231	71	1.08	0.06		653	96	0.99	0.14
		M09	IS	20	479.5	588	29	1.23	0.06	1157.0	1275	81	1.10	0.07	677.5	687	90	1.01	0.13
			RPS	20		565	64	1.18	0.13		1263	89	1.09	0.08		698	125	1.03	0.18
			WLS	20		611	50	1.27	0.10		1257	58	1.09	0.05		645	85	0.95	0.13
		M12	IS	20	496.0	618	51	1.25	0.10	1149.1	1271	115	1.11	0.10	653.1	653	153	1.00	0.23
			RPS	20		651	68	1.31	0.14		1239	87	1.08	0.08		587	91	0.90	0.14
			WLS	20		663	92	1.34	0.19		1238	58	1.08	0.05		576	84	0.88	0.13
	OUMC	M32	IS	20	497.6	665	48	1.34	0.10	1221.6	1347	178	1.10	0.15	708.2	682	192	0.96	0.27
			RPS	20		622	86	1.25	0.17		1393	186	1.14	0.15		771	238	1.09	0.34
			WLS	20		689	40	1.38	0.08		1398	123	1.14	0.10		709	129	1.00	0.18
		M35	IS	20	452.8	603	32	1.33	0.07	1091.8	1143	73	1.05	0.07	639.0	540	79	0.85	0.12
			RPS	20		525	67	1.16	0.15		1220	199	1.12	0.18		696	200	1.09	0.31
			WLS	20		552	59	1.22	0.13		1152	93	1.05	0.09		600	77	0.94	0.12