EXPERT REPORT OF NATALIE SCHILLING, PH.D.

Linguistic Analysis of American Airlines Flight 11 Transmissions Purported to be Made by Mohamed Atta on 11 September 2001

Prepared for the International Center for 9 /11 Justice

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Natalie Schilling
Signed

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I. INTRODUCTION

I was asked by the International Center for 9/11 Justice to conduct a linguistic analysis of the three transmissions purportedly made by alleged 9/11 hijacker Mohamed Atta from American Airlines Flight 11 on 11 September 2001, prior to the plane's crashing into the North Tower of the World Trade Center. These transmissions occurred at 082444 a.m. (18 words), 082457 (22 words), and 083359 (17 words). The main questions I was asked to consider are:

A. Is the English accent of the voice purported to be Atta's consistent with that of a native speaker of Arabic, as Atta was known to be? If not, are there accents with which it is consistent?

B. Could Atta's English have been different from typical Arabic English due to his language experiences and exposures over the course of his life?

C. Could people mistakenly believe they hear an Arabic English accent when listening to someone with a different accent? Could they mistakenly believe it is Atta's voice if in fact someone else's?

These questions were put to me in light of the fact that, as represented to me, there is no known audio of Atta's voice, including his voice when speaking English.

In linguistics and in the report below, the term 'accent' refers to pronunciation features of a language or language variety, including vowel and consonant pronunciations as well as issues pertaining to pitch, intonation, and word and sentence stress (emphasis). 'Dialect' refers to a language variety encompassing not only accent or pronunciation features but also grammar (syntax) and vocabulary (lexicon) features.

To answer the above questions, I relied on my extensive knowledge of English dialect variation and of language and dialect acquisition, variation, maintenance, and change more generally. I compared the AA11 transmissions with established descriptions of Arabic English and other varieties, including several I was specifically asked to consider: Caribbean English (e.g. Jamaican English, Bahamian English, Trinidadian English) and Israeli English. I also considered some sample varieties of African English (Ghanaian English, Nigerian English), as these have been held to sound similar to Caribbean varieties. In addition, I performed audio comparisons by examining the AA11 audio against recordings of relevant dialects from the vast repository of the International Dialects of English Archive (https://www.dialectsarchive.com/). I further compared the A11 transmissions to two transmissions from United Airlines Flight 93 purported to be from Ziad Jarrah, occurring at 0932 and 0939.

To assess question (B), I considered Atta's language background, including his experience with and exposures to Arabic, English, and German, as well as his motivations for language and dialect acquisition and change.

Finally, regarding (C), I relied on my knowledge of how people perceive languages, dialects, accents, and their speakers, as well as the factors affecting people's ability to recognize individual voices, to consider whether people's perceptions of the accent heard in the AA11 transmissions, or identification of the voice of the speaker, could be mistaken.

In addition to the central questions above, I was also asked to consider several additional issues:

D. Can linguistic analysis shed light on what was said during an indistinct portion of the UA93 transmission (occurring shortly after 0928) that appears to contain two instances of the word 'mayday'? Is there anything questionable about this utterance from the point of view of semantics (linguistic meaning), pragmatics (meaning in context), or sociolinguistics (language in everyday use, including how people shape their language in different circumstances and why)?

E. Can linguistic analysis shed light on what was whispered at the end of the 47-second voicemail left by UA93 flight attendant CeeCee Lyles for her husband?

II. BACKGROUND AND QUALIFICATIONS

I am a Professor Emerita of Linguistics at Georgetown University, where I was a member of the faculty for 23 years and was tenured for 18 years.

As a Professor of Linguistics, I designed and taught a number of graduate and undergraduate courses focused on many areas of linguistic study, including General Linguistics (which includes phonetics and phonology, the study of language sounds), Sociolinguistics, Sociolinguistic Variation, American Dialects, Style and Stylistic Variation (variation within individuals), Sociolinguistic Research Methods, and Forensic Linguistics.

Throughout my scholarly and academic career, I have specialized in Sociolinguistics, the study of the interrelation between language and society. Within this, I have focused on the history, structure, meaning, and use of American English, with a particular interest in language variation and change across speaker groups (e.g. regional, ethnic, gender, and other social groups) and situations of use (stylistic variation), including pronunciation variation. I have also focused on forensic linguistics, the application of linguistic principles and analysis to legal matters.

I have authored, co-authored, or co-edited ten books, 47 journal articles and book chapters, nine articles in conference proceedings, and a number of book reviews and outreach publications and presentations, all on various issues in linguistics. I have designed and delivered 150 conference presentations and invited lectures in academic

settings, including 10 keynote presentations at national and international conferences. I also authored and delivered an audio/video course for The Great Courses lecture series.

I was awarded the title of Professor Emerita at Georgetown University in 2023. I was a Professor of Linguistics at Georgetown from 2017-2023, an Associate Professor there from 2005 to 2017, and an Assistant Professor there from 1999-2005. I received tenure in 2005. From 1998 to 1999, I was an Assistant Professor of English at Old Dominion University. From 1997-1998, I was an Andrew W. Mellon Postdoctoral Researcher in the Humanities in the Stanford University Linguistics Department. I have also served as Assistant Professor and Instructor at North Carolina State University and Duke University.

I earned a Bachelor of Arts in English from the University of North Carolina at Chapel Hill in 1986, a Master of Arts in English from North Carolina State University at Raleigh in 1993, and a Doctorate in Linguistics from the University of North Carolina at Chapel Hill in 1996.

I was inducted as a Fellow of the Linguistic Society of America in 2022. LSA Fellows are "Members of the Society who have made distinguished contributions to the discipline."

In preparing this report, I relied on my knowledge, training, education, skill, and experience in the field of Linguistics, as well as the materials cited in this report. Additionally, the facts and data I considered are set forth in the following paragraphs.

III. DATA ANALYZED

Audio data was provided to me by the International Center for 9/11 Justice and is transcribed as follows. Unclear utterances are in curly brackets; possible alternative transcriptions are in square brackets:

AA11-1, 082444:

> {Buddy}, we have some planes. Just stay quiet and we'll [you'll] be okay. We are returning to the airport.

AA11-2, 082457:

> Nobody move[s]. Everything will be okay. If you try to make any moves, you'll endanger yourself and the airplane. Just [let's] stay quiet.

AA11-3, 083359:

> Nobody move[s], please. We are going back to the airport. Don't try to make any stupid moves.

UA93-1, shortly after 0928:

> {Shouted utterance, possibly 'Mayday! Get outta here! Mayday! Get outta here!' or 'Mayday! We're gonna die here! Mayday! We're gonna die here!'}

UA93-2, 0932:

> {Unclear} Keep remaining sitting. We have a bomb on board, so

UA93-3, 0939:

> This is [uh, here's] the captain. I would like you all to remain seated. We have [There's] a bomb on board [aboard] and are going back to the airport, and have our demands, so please remain quiet.

CeeCee Lyles, end of phone call to husband:

> {Whispered utterance, possibly 'It's a frame'}

As noted above, there is no known audio of Atta's voice against which to compare the AA11 transmissions. Even if such audio were to come to light, a comparative analysis may not be determinative, as voice identification is quite difficult, even with advanced computational technologies, and the AA11 data is limited in quantity and of noisy quality. 'Voiceprint' comparison similar to fingerprint comparison does not (yet) exist. While each person has a unique way of using language (an idiolect), a language sample is not comparable to a fingerprint or DNA sample, as any given language sample represents only a portion of that person's overall language data, not necessarily all the material needed to differentiate across individuals; people's language behavior changes over time and in different situations; and people share considerable language data with others (e.g. with people of the same dialect background).

IV. SUMMARY CONCLUSIONS

My summary conclusions are as follows:

A. Analysis of AA11 accent and comparison with other second-language English accents and dialects

1. Accent features of the AA11 voice

The voice of the purported hijacker in the AA11 transmissions exhibits a number of accent features that are consistent with many second language varieties of English around the world, as well as native dialects with origins in L2 English, for example Caribbean Englishes. These features include 'clipping' of the vowels in 'please', 'plane', 'okay', and 'move'; r-dropping or r-weakening in 'airport' (and possibly 'airplane' as well); unreduced (fully pronounced) vowels in unstressed syllables (e.g. 'to'); stress shift in 'airport' (pronounced 'airPORT') and 'airplane' (pronounced 'airPLANE'), and a relatively wide pitch range in transmission AA11-3, where alternating low and high pitch gives the utterance a 'sing-song' intonation (pitch contour). The three transmissions, AA11-1, AA11-2, and AA11-3 are all purported to have been made by a single individual. There is no linguistic evidence to suggest otherwise. The speaker is quite comprehensible by native English speakers, despite his L2 accent features. This suggests relative fluency in English.

2. AA11 accent vs. Arabic English

Several features of the AA11 accent are consistent with Arabic English, namely, vowel clipping, unreduced vowels, and stress shift. However, **two features are inconsistent with Arabic English: r-dropping** (also called 'arhoticity' or 'r-lessness') **and the relatively wide pitch range in AA11-3**. Arabic English is not characterized by r-dropping but instead by a trilled ('rolled') r. The trilled /r/ is produced by quite different articulatory mechanisms than omitted or weakened /r/. In fact, it is one of the most distinctive, noticeable features of Arabic English and helps set it apart from many other L2 and L2-influenced varieties of English.

In addition, Arabic English is NOT characterized by wide pitch variation but rather its opposite: Studies show that speakers of Arabic English typically exhibit a narrower pitch range than native speakers of mainstream American and British English, giving them a 'monotone' intonational quality. The AA11 speaker exhibits pitch variation rather than monotone speech, including sing-song intonation in AA11-3.

The features that are inconsistent with Arabic English are independent of one another; there is nothing about how /r/ is articulated that affects intonational contour and vice versa.

3. AA11 vs. other accents

Like the AA11 accent, **Caribbean English** varieties are characterized by clipped vowels, unreduced unstressed vowels, stress shift, and wide pitch range, including, in some varieties, alternating low and high pitch, or 'sing-song' intonation (e.g. Jamaican English). Some Caribbean dialects also have extensive r-dropping (e.g. Trinidadian English), while others have more r-pronunciation (Jamaican English) or variable r-dropping depending on individual, social group, etc. (Bahamian English). **African English** dialects like Ghanaian English and Nigerian English also have clipped vowels, stress shift, sing-song intonation, and r-lessness. Despite the shared features, there are nuanced pronunciation differences across varieties, including in how vowels preceding dropped /r/ are pronounced. The AA11 speaker's pre-/r/ vowel pronunciations align with those typical of Caribbean English varieties like Jamaican English and Bahamian English.

Like the AA11 accent, **Israeli English** also has clipped vowels, unreduced unstressed vowels, and stress shift. However, it is NOT typically r-less. Instead, Israeli English usually has /r/ pronounced far back in the throat, uvular /r/. It may also include trilled or rolled /r/, similar to Arabic English. Israeli English also includes a couple other features NOT heard in the AA11 audio: a strong /h/ pronunciation (i.e. velar or uvular /h/) at the beginnings of words (e.g. 'have') and the inclusion of a /k/ sound at the end of words like 'returning' and 'everything'.

4. Lexical feature of AA11: 'buddy'

An unclear utterance at the beginning of 'We have some planes' (in AA11-1) has sometimes been transcribed as 'buddy'. Spectrographic analysis indicates that this is a reasonable interpretation. This term of address is typically associated with American English rather than other dialects. The Oxford English Dictionary indicates that this word has Caribbean origins. If the word is indeed 'buddy', this strengthens the dialect similarities between the AA11 voice and Caribbean varieties like Bahamian English.

5. AA11 vs. UA93

The UA93 speaker in utterances UA93-2 and UA93-3 shares clipped vowel pronunciations and unreduced unstressed vowels with the AA11 speaker. **The UA93 speaker also has two features of Arabic English the AA11 speaker lacks: trilled /r/** (in 'remaining', 'remain') **and a relatively monotone delivery** (narrow pitch range). These linguistic differences suggest possible different dialect origins between the two speakers.

6. Summary of comparisons and cautions

In short, the AA11 accent shares features consistent with many L2 and L2-influenced varieties of English. There are two inconsistencies with Arabic English: lack of trilled /r/ (and inclusion of r-dropping) and relatively wide pitch range in AA11-3. These features are linguistically independent of one another. There are also inconsistencies with Israeli English: lack of uvular /r/ (and inclusion of r-dropping), lack of strong /h/, and lack of /k/ after 'ing'. There are consistencies with Caribbean and African varieties of English. On balance, the accent shares more with Caribbean varieties, given the pronunciation of the vowel preceding r-less 'port' (i.e. as a diphthong or two-part vowel rather than one-part vowel; see below for details).

These conclusions should be taken with some caution: There are many L2 and L2-influenced varieties of English across the world that share common features; the AA11 audio is quite noisy (and the UA93 audio is even worse); and there is little language data (57 words spoken by the purported AA11 hijacker, 34 unique words), and so crucial accent features could be missing. In addition, there is variation in pitch range even with speakers of the same dialect, and it is possible for an individual native Arabic speaker to have a wide pitch range, though it would not be expected.

It must also be taken into consideration that the accent in the AA11 transmissions may be a disguise – an attempt to imitate an Arabic English dialect by someone who is not a native speaker. In general, people are not very accurate in imitating dialects, and so it would not be surprising if someone attempting to fake an Arabic English dialect would inadvertently leave out some features that are commonplace in the dialect (e.g. trilled /r/) and include 'extra' features that are not common in Arabic English (e.g. the 'sing-song' intonation that is typical of a number of other varieties of L2 English). It is not likely that the speaker is a native Arabic speaker attempting to mask his Arabic English accent, as it would be very

difficult for someone who usually has trilled /r/ to produce it differently, especially under stress.

B. Atta's language background and linguistic influences

Presuming general sources on Atta's background to be fairly accurate, it is reasonable to assume that he would have learned English from a young age, and the dialect he would have acquired would have been Arabic English, given his upbringing in a middle-class family in Cairo. He reportedly learned German after university and lived in Hamburg for about eight years, with travel during that time to Egypt, Saudi Arabia (Mecca), and likely Afghanistan and Pakistan. He is reported to have been quite anti-social while in Germany. He lived in the U.S. for a little over a year. There is no indication that Atta visited or lived in the Caribbean or had significant interaction with speakers of Caribbean English. Some sources report that Atta knew French, Hebrew, and possibly other languages in addition to Arabic and English. Atta is also reported to have been self-isolating and to have avoided interactions with native residents while in Germany and the U.S.

People's accent features are well-established by late adolescence, and beyond this age it requires considerable effort, language exposure, and motivation to alter one's native pronunciation features when speaking a non-native language or dialect. It is therefore unlikely that Atta's Arabic English accent would have been significantly influenced by German, German-accented English, or other languages and dialects he would have encountered as an adult uninterested in interacting with native speakers. There is no indication that he ever visited or lived in the Caribbean or had significant interaction with speakers of Caribbean English.

Even if Atta was influenced by German or French, there is no indication of a German or French accent in the AA11 voice. Both of these L2 varieties of English are characterized by uvular /r/ production, not r-dropping, among other linguistic differences. The accent is also not typical American English, since this variety is also characterized by r-pronunciation, in this case, retroflex /r/.

If the voice in the AA11 transmissions is Atta's, then he likely would have had some linguistic influence other than what would be expected given what is generally known about his background. It is unlikely he would have developed an idiosyncratic way of speaking English not based directly on his language influences, as people do not usually adopt dialect features for no reason.

It is also not likely that the AA11 voice is that of another purported AA11 hijacker. It was represented to me that these men were not very fluent in English, and so they would have been expected to be less comprehensible than the AA11 speaker. Further, if they did speak English, they too should have had Arabic English accents (including trilled /r/) rather than a Caribbean-sounding variety, since they were from Saudi Arabia.

Again, to the best of my knowledge, there is no known audio of Atta's voice, and even if a recording were to come to light, comparative analysis may not be determinative.

C. Accent and voice identification

It is well known in linguistics that people's perceptions of language can be influenced by visual and social priming. Experiments have shown that when people expect to hear an L2 accent (e.g. when they are shown a 'foreign' face), they believe they hear one, even when the actual audio stimulus is a native speaker. They can also be primed to hear specific accents, words, or sounds. It is therefore not surprising that people listening to the AA11 audio who know its context would believe they hear an Arabic English accent, regardless of the actual pronunciation details of the voice. Then and now, listeners were primed to hear such an accent by widespread accounts that the 9/11 attackers were Arab terrorists, individuals who would be expected to have Arabic English accents.

It is also well known in linguistics that non-linguists are not very accurate in dialect identification, particularly when are not very familiar with the accent in question. This is partly because of the nature of dialect variation: Dialects are composed not primarily of unique features but by unique combinations of features, many of which are shared with other dialects.

As noted above, the AA11 voice has a number of dialect features common in L2 and L2-influenced varieties of English; the combination of features in the AA11 voice does not point clearly to any one variety. However, it does indicate inconsistency with what would normally be expected in Arabic English.

It is largely taken without question that the voice on the AA11 transmissions is that of an Arabic English speaker; however, this widespread 'identification' may well be mistaken and cannot be taken as definitive evidence of the speaker's actual dialect origins. Further, it has mostly been taken without question that the AA11 voice is Atta's. To the best of my knowledge, there has never been an official attempt to formally identify the voice as Atta's.

Should claims to voice identification in this matter come to light, they should be taken with caution. Research shows that voice identification by non-experts, also called 'earwitness identification', is not very accurate, especially if there is a delay between when the listener was exposed to the voice and when they were asked to make the voice identification and if the voice identification task is flawed (e.g. if it consists of a single voice rather than a properly constituted voice line-up). It was represented to me that there are no reports of voice identification by people familiar with Atta's voice when speaking English that were made close to the 9/11 date or that were obtained via reliable voice identification procedures.

D. Linguistic analysis of 'mayday' portion of UA93 (UA93-1)

It was represented to me that the UA93 utterance in question may consist of the words, 'Mayday! Get outta here', spoken twice in rapid succession. Auditory assessment (i.e. close listening by a trained linguist) and acoustic analysis (i.e. examination of the sound waves of speech) indicates nothing inconsistent with this interpretation; however other interpretations are possible, for example 'Mayday! We're gonna die here!' From the point of view of linguistic pragmatics (meaning in context), the latter interpretation is more plausible: If the first word is 'Mayday', this indicates that the transmission is being directed to air traffic controllers, not the hijackers, and so it makes sense that the words following 'Mayday' would be directed at ATC as well. 'Get outta here!' would seemingly be directed at hijackers invading the cockpit; 'We're gonna die here!' is directed outward (though the pilot does not explicitly address ATC, as would be expected in an aviation emergency).

Again, conclusions must be taken with caution, as the audio is very noisy, and the utterances are shouted (even screamed) with a high degree of emotionality.

If the utterance in question is indeed an emotional call of 'Mayday!', followed by other emotional language, it raises questions from a sociolinguistic and pragmatic point of view. Highly skilled jobs like commercial airline pilot have much specialized vocabulary (jargon), as well as routine procedures specialists are trained to follow in a wide range of circumstances (i.e. interactional 'scripts' that must be followed). Investigators should consider whether the transmission of 'Mayday!' is aligned with standard procedure for alerting ground control of emergency situations such as hijacking (e.g. stating 'Mayday!', the name of the station addressed, and the aircraft ID). Investigators will also want to consider whether the content and emotionality of the utterance aligns with what has been observed in pilots in previous life-threatening emergency situations, including hijackings and attempted hijackings.

E. Analysis of whispered utterance at the end of the CeeCee Lyles call

It was represented to me that the whispered utterance at the end of the Lyles call might be 'It's a frame' or 'You did great'. Auditory and acoustic analysis indicate consistency with 'It's a frame' but less consistency with 'You did great'. Different vowel sounds have different 'signatures' consisting of bands of energy at different pitch levels (frequencies). These bands can be seen on spectrograms – graphs that plot frequencies against intensity (loudness). In the utterance in question here, the bands of energy are consistent with the vowels 'ih' (as in 'it's'), 'uh' ('a'), and 'ey' (as in 'frame'). They are less consistent with the vowels in 'You did great'. Again, a definitive determination cannot be made, since part of the audio signal is lost when voices are transmitted long-distance and when utterances are whispered (which removes vocal fold vibration normally present for all vowels and many consonants).

V. DETAILS OF ANALYSIS

A. Analysis of the AA11 accent and comparison with other second-language English accents and dialects

1. Accent features of the AA11 voice

The voice of the purported hijacker in the AA11 transmissions exhibits accent features consistent with a number of non-native English varieties, as well as native dialects with original L2 influence (e.g. Jamaican English), though it is highly comprehensible to native speakers, suggesting fluency in English. The L2 features include:

a. 'Clipping' of the vowels [i] (as in 'please'), [e] (as in 'plane'), [o] (first vowel in 'okay'), [u] ('moves')

These vowels are pronounced as two-part vowels (diphthongs) in native English but as one-part vowels (monophthongs) in a number of non-native varieties, as well as native varieties influenced by L2 dialects. The feature is consistent with the L2 English of native speakers of Arabic but also with other dialects including African Englishes and Caribbean Englishes.

b. R-dropping in 'airport', with [r] replaced by vowel glides, so that 'airport' sounds like 'eh-uh-poo-uh-t' [ɛə puət] or 'eh-uh-paw-ut' [ɛə pɔət]

R-dropping is quite common in English varieties around the world and is in fact a feature of standard British English, which serves as the model for second-language English teaching and learning in most of the world. However, it is NOT typical of the L2 English of native speakers of Arabic, who tend to pronounce /r/ using a non-native trilled pronunciation.

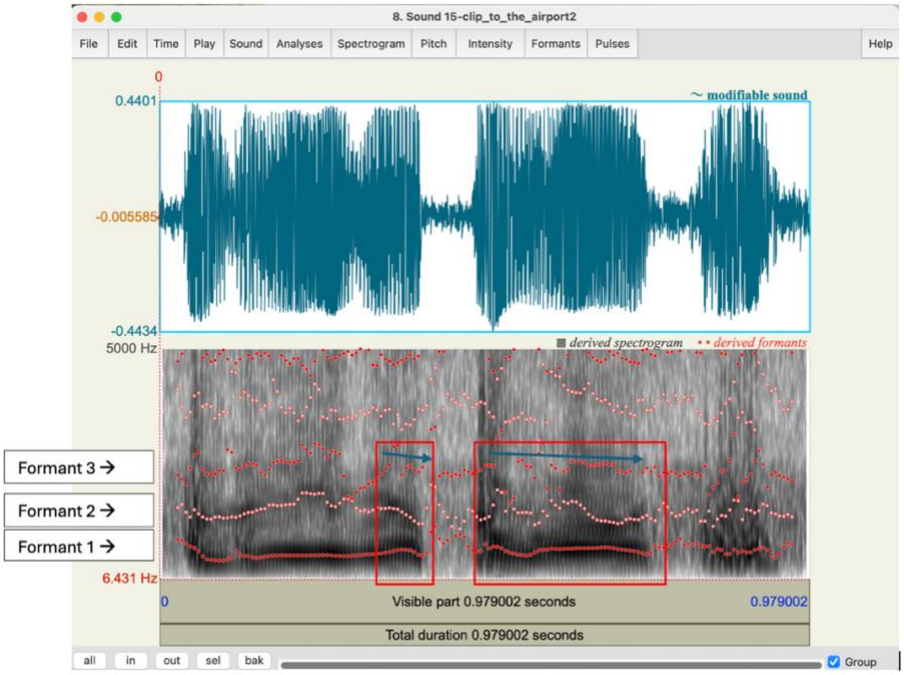
R-dropping consistently follows the same pattern, regardless of dialect: /r/ may be variably weakened (pronounced more like a vowel) or dropped when it occurs at the end of a syllable or in a group of consonants at the end of a syllable, as in 'air' and 'port'. It is always retained in syllable-initial position and in groups of consonants in this position, as in 'try' or the first /r/ of 'returning'. However, there are differences across dialects in how vowels preceding dropped /r/ are pronounced; in some varieties, these vowels are lengthened and may even be split into two-part vowels (diphthongs), consisting of the main vowel (nucleus) plus a shorter vowel (glide). The AA11 speaker exhibits some gliding, especially in the word 'airport', so that the first vowel sounds something like 'eh uh' [ɛə] and the second like 'oo uh' [uə] or 'aw uh' [ɔə].

Glided vowels with r-less pronunciations are typical in Caribbean English (though Trinidadian English may be less glided); African Englishes like Ghanaian English and Nigerian English) tend to have less glided vowels before dropped /r/. Israeli English is not typically r-less but instead has uvular /r/.

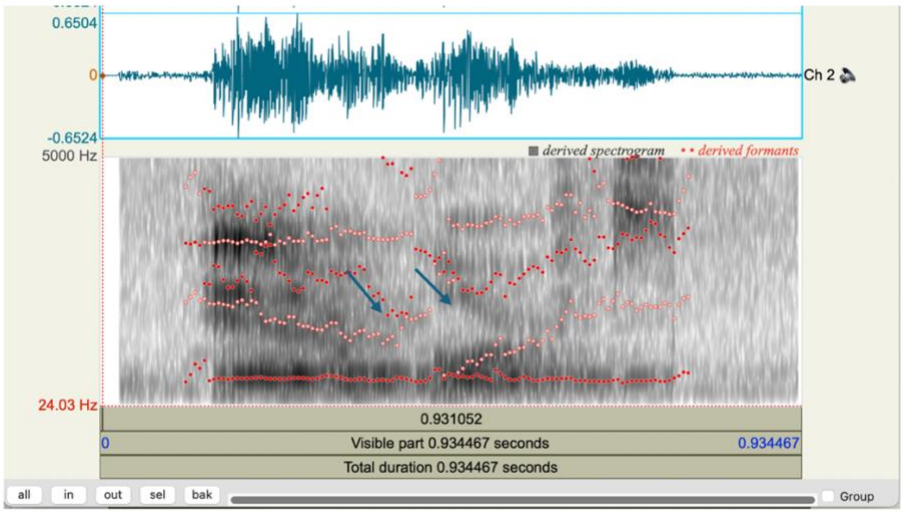
Acoustically, /r/ is characterized by a drop in frequency of its third band of energy, or third formant (F3). R-less pronunciations will not show this frequency drop; instead, the third

formant will remain steady. The difference can be seen in the following two spectrograms. The x-axis shows elapsed time; the y-axis shows frequency, and intensity or loudness is indicated by degree of darkness. The dark bands running horizontally across the graph (here also highlighted with red and pink dots) are the bands of energy, formants, that give each language sound its distinctive signature. The first graph below is 'to the airport' from AA11-3; the second is 'the airport', uttered by a person known to be a speaker of Arabic English. In each diagram, blue arrows indicate the directionality of the third formant.

i. 'to the airport', AA11-3 ('air' and 'port' indicated with red boxes; formants indicated with dotted lines); third formant is steady, indicating r-lessness:

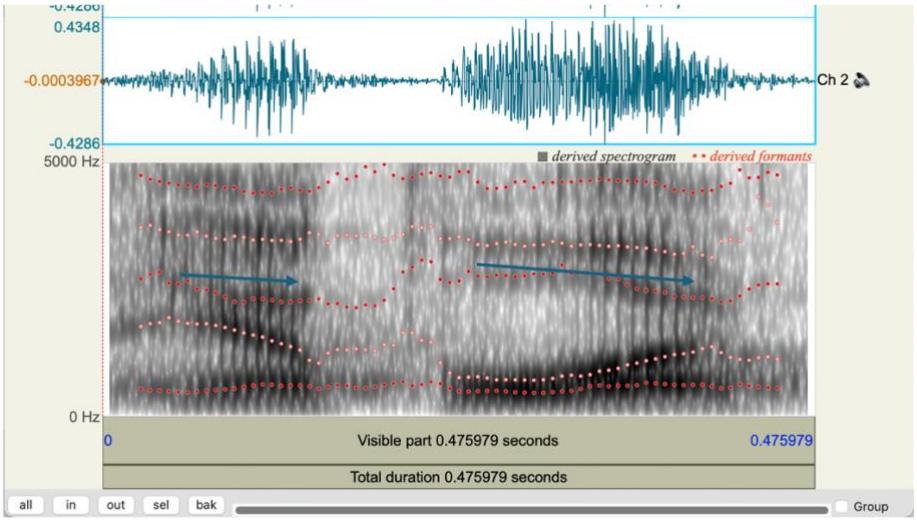


ii. 'the airport', known Arabic English speaker; third formant drops in each syllable, indicating /r/ pronunciation:



In addition, the AA11 speaker can be compared with a known speaker of a Caribbean variety, in this case Bahamian English. Note again the horizontal third formant bands indicating r-less pronunciations of 'air' and 'port':

iii. 'the airport', known speaker of Bahamian English:



It can also be noted that the first and second formants of the vowels in 'air' and 'port' in (i) and (iii) above are not horizontal but show pitch changes. This indicates the gliding (diphthongal) rather than steady-state (monophthongal) character of these vowels for these two speakers.

c. Unreduced vowels in unstressed syllables such as 'to'

Native English speakers typically reduce the vowels in unstressed syllables to schwa, as in:

Native English: We are going back **t'** the airport vs.
Non-native English: We are going back **to** the airport

d. Stress shift in 'airport' and 'airplane' in transmissions AA11-1 and AA11-2 (stressed syllable indicated in ALL CAPS):

Native English: AIRport, AIRplane
Non-native English: airPORT, airPLANE

e. Intonation

The AA11 transmissions are characterized by the following intonational patterns:

i. Steady or rising pitch at the ends of some sentences rather than the falling pitch that typically characterizes native English declarative sentences:

We have some planes
We are going back to the airport

ii. Falling pitch at the ends of some sentences:

Just stay quiet and you'll be okay.
Nobody move.
Everything will be okay.
Just stay quiet.
Don't try to make any stupid moves.

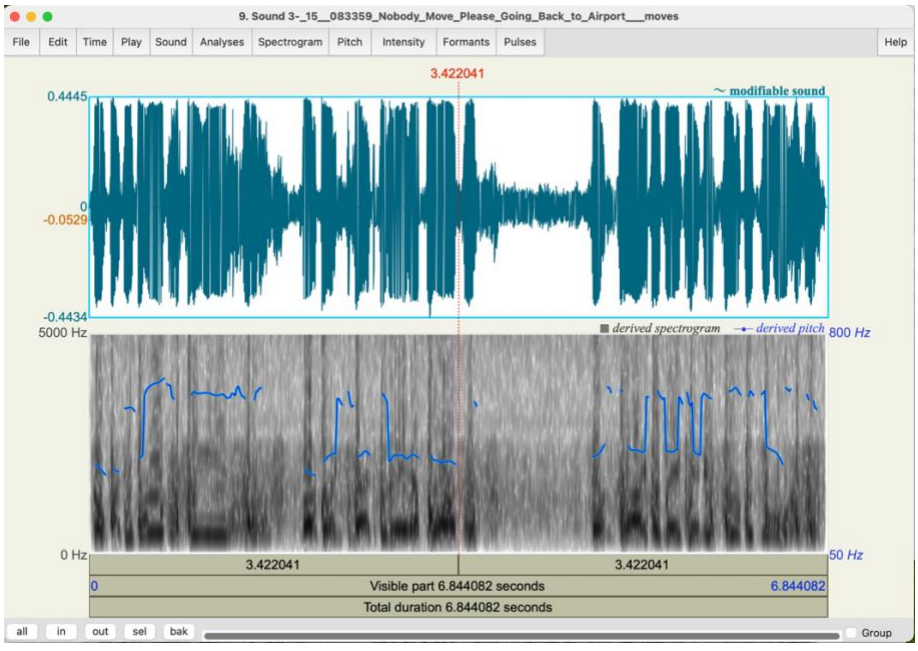
iii. 'Sing-song' intonation produced by wide pitch range and alternating high and low pitch in transmission AA11-3:

Nobody move, please. We are going back to the airport.

Wide pitch range and 'sing-song' intonation are well-known to characterize Caribbean Englishes. They also characterize African Englishes like Ghanaian English and Nigerian English. L2 English speakers whose native language is Arabic tend to speak English using a narrower pitch range, more of a monotone delivery, than native speakers. The AA11 speaker is not monotone but has pitch variation, especially in AA11-3.

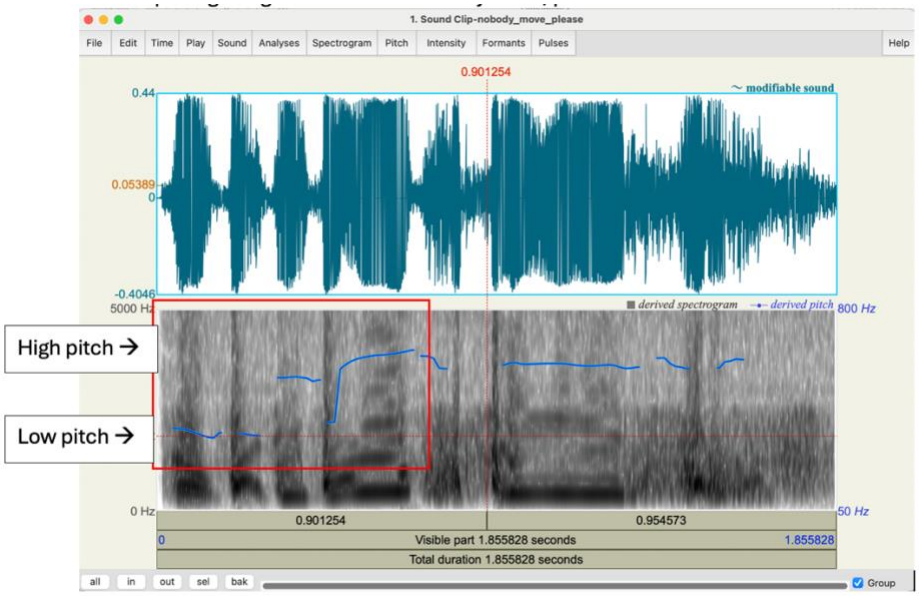
A spectrogram of AA11-3 with the intonational contour (pitch track) marked in blue is presented below.

iv. Nobody move[s], please! We are going back to the airport. Don't try to make any stupid moves:



The noisy audio makes it difficult to get a clear pitch track; however, the 'sing-song' pattern that is clearly heard by ear can be detected in this close-up of 'Nobody move, please!':

v. Nobody move[s], please!:



f. Absence of Arabic English trilled /r/ in AA11:

As noted, in dialects characterized by arhoticity, r-dropping is variable in syllable-final position but always retained in syllable-initial position. When /r/ is present in the utterances in the AA11 transmissions, it is pronounced as in British or American English (i.e. as either a retroflex /r/ or flapped /r/) rather than as a trill, the latter which is a distinguishing feature of L2 English by native Arabic speakers. In the phrases below, non-trilled /r/ is indicated with capital R:

i. We are **Returning**

ii. **EveRything** will be okay.

ii. If you **tRy** to make any moves

2. AA11 vs. Arabic English

As noted above, AA11 lacks several distinctive features of Arabic English. Most notably, it lacks trilled /r/ but instead has r-dropping. The AA11-3 transmission also shows more pitch variation than would be expected in Arabic English. The contrast in r-pronunciation between the AA11 voice and Arabic English can be seen in the spectrograms in (b.i) and (b.ii) above; the wide pitch range in AA11 is seen most clearly in (e.v) above.

3. AA11 vs. other accents

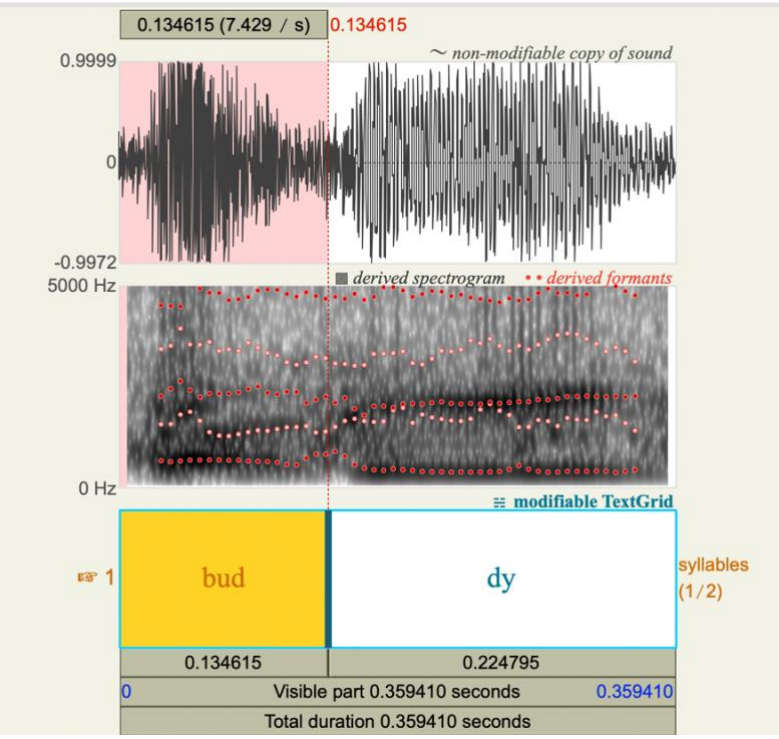
As noted above, AA11 shares features consistent with many L2 and L2-influenced English varieties, including Caribbean and African varieties: clipped vowels, unreduced unstressed vowels, stress shift, and wide pitch range. The AA11 voice also shares vowel-gliding before omitted /r/ with other dialects; in particular, gliding of the vowel in 'port' is shared with Caribbean dialects (though Trinidadian English tends to have less gliding).

AA11 also shares clipped vowels, unreduced unstressed vowels, and stress shift with Israeli English. However, the AA11 voice does NOT have several distinctive features of Israeli English, including uvular /r/ ('guttural r'), strong /h/ (uvular or velar /h/), and a /k/ sound at the end of words with 'ing' endings (e.g. 'everything', 'returning').

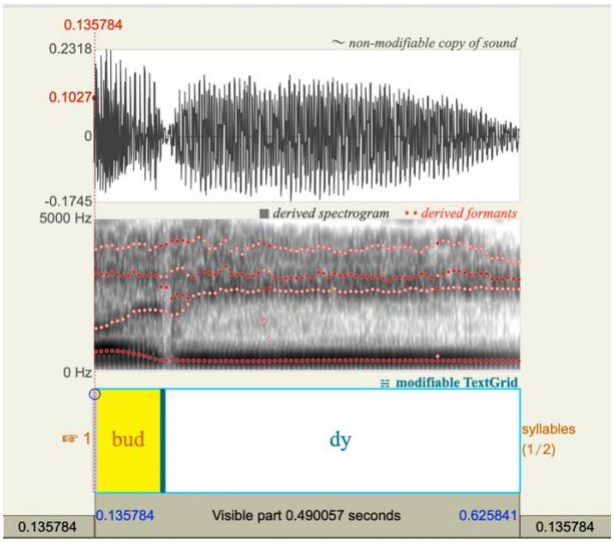
4. Lexical feature of AA11: 'buddy'

An unclear utterance at the beginning of AA11-1 may appear in transcripts as 'buddy'. Spectrographic analysis indicates that this is a reasonable interpretation. Comparative spectrograms of the AA11 utterance and a clear utterance of 'buddy' are show below. In each case, the dark horizontal bands (vowel formants, marked here by red and pink dotted lines) show values compatible with the 'uh' and 'ee' vowels of 'buddy'. The spectrogram also indicates a two-syllable word in which the two syllables are separated by constriction in the mouth, characteristic of consonants such as 'd':

a. AA11, possible 'buddy':



b. Clear utterance of ‘buddy’:



Interestingly, if the word in the AA11 transmission is indeed ‘buddy’, it strengthens similarities with Caribbean English. The word is typically associated with American English rather than other varieties; however, the Oxford English Dictionary indicates that ‘buddy’ originated in the Caribbean:

> OED definition of ‘buddy’
> https://www.oed.com/dictionary/buddy_n?tab=meaning_and_use
>
> 1.a.
> 1788–
> colloquial (originally Caribbean, now chiefly U.S.). Used as a familiar form of address to a man or boy, sometimes one whose name is not known.

5. AA11 vs. UA93

The speaker in UA93-2 and UA93-3 shares some pronunciation features with the A11 speaker:

a. ‘Clipping’ of the vowels [i] (as in ‘please’, ‘seated’), [e] (second vowel in ‘remain’), [o] (first vowel in ‘going’)

b. Unreduced vowels in unstressed syllables such as ‘to’:

> I would like you all **to** remain seated
> We … are going back **to** the airport

c. Possible r-lessness in ‘airport’ and ‘aboard’, though the exact pronunciation is difficult to determine, due to the very noisy audio:

However, there are a few features not shared between the UA93 speaker and the A11 speaker:

d. The UA93 speaker has a relatively narrow pitch range, and his utterances are flatter in intonation, possibly with slightly rising pitch at the ends of sentences. Narrow intonational range/monotone delivery is typical of Arabic English. (Background noise does not enable the production of a clear pitch track.) This contrasts with the pitch variation in the AA11 speakers voice, especially in AA11-3. The following illustrates the relatively monotone delivery of the UA93 (with pitch drop at the end of the utterance):

> This is [uh, here's] the captain. I would like you all to remain seated. We have [There's] a bomb on board [aboard] and are going back to the airport, and have our demands

e. The UA93 speaker has the trilled /r/ that the AA11 speaker lacks, in the phrases below (trilled /r/ indicated with [r̃]):

i. Keep **[r̃]**emaining sitting

ii. I would like you all to **[r̃]**emain seated

(Note also the non-native grammar in 'keep remaining sitting')

f. The UA93 speaker does NOT have stress shift on 'airplane' and 'airport'

In other words, the UA93 speaker has more features of Arabic English than the AA11 speaker, including the distinctive trilled /r/ and relatively monotone intonation variation typical of Arabic English. These linguistic differences suggest possible different dialect origins between the speakers in the AA11 and UA93 audio. Again, though, the data is of limited quantity and quality, and caution must be exercised in making a definitive conclusion. (For example, due to noise it is hard to ascertain whether the UA93 speaker exhibits r-lessness in 'airport'; in contrast, r-lessness is evident in AA11.)

6. Summary of comparisons and cautions

In sum, the AA11 accent is consistent with many L2 and L2-influenced varieties of English but inconsistent in a couple important ways from Arabic English: The AA11 voice has r-lessness rather than trilled /r/ and varied pitch rather than monotone intonation including sing-song intonation in AA11-3. The AA11 voice is also inconsistent with Israeli English in terms of /r/, /h/, and lack of /k/ in 'ing' endings.

Due to the limited linguistic material and to the presence of noise in the audio, it is not possible to make a definitive determination of the native dialect of the AA11 speaker. The constellation of features suggests a speaker of a Caribbean variety of English such as Bahamian English (with somewhat less similarity to the African Englishes considered). It cannot be ruled out that this is a native Arabic speaker, since there is variability in all

dialects, as well as in every individual, and a given individual may not use every typical feature in every instance. In addition, it is not possible to compare the AA11 voice against every dialect of English across the globe. However, the prominent r-less, lack of trilled /r/, and sing-song intonation raise doubt that the native language of the AA11 speaker is Arabic (though as noted above, there can be variability in pitch range among speakers of the same dialect).

The possibility must also be considered that the accent in the AA11 transmissions may be a disguise – an attempt to imitate an Arabic English dialect that falls short by failing to include certain features, even highly prevalent, prominent features like trilled /r/, and including atypical ones like r-lessness and sing-song intonation. It is not likely that the AA11 voice is that of native speaker of Arabic attempting to mask his Arabic English dialect, as it would be very difficult for someone who usually has trilled /r/ to produce it differently, especially under stress. (In fact, English lessons for native speakers of Arabic feature targeted exercises for eliminating trilled /r/, since this pronunciation is so hard to change.)

B. Atta's language background and linguistic influences

1. Overview

Based on standard accounts of Atta's life, he was from a well-to-do or middle-class family with educated parents. It is likely that he grew up studying English, as this was and is common for educated people in Egypt, and so his English would have been quite fluent. It is highly likely that he acquired English with an Arabic English accent, not with native pronunciations, since English would have been a school subject to him, not an everyday means of communication, and he would have had more exposure to speakers of Arabic English than native speakers of English (if any of the latter).

Atta obtained a degree in architecture from Cairo University. It is unclear whether his university courses were in Arabic, English, or another language. Likely some of them, especially science and engineering courses, were in English.

After university, Atta studied German at a German-language institute in Cairo, in preparation for graduate study in Hamburg. He moved to Hamburg around 1992 and lived there until leaving for the US in 2000, with extended travel to Egypt, Saudi Arabia (Mecca), and likely Afghanistan and Pakistan.

2. Influence of German or German-accented English?

It is not likely that Atta's L2 English dialect was greatly impacted by his eight-year stay in Germany. The languages and dialects that people acquire as children usually do not drastically change after adolescence. Atta would have already been age 24 when he moved to Germany for his studies. He is also reported to have been very anti-social, with limited interaction with fellow students and others. This would have limited his exposure to conversational German or conversational German-accented English. In addition, the self-isolating Atta would not have been motivated to adapt linguistically to his surroundings,

and it is well known in linguistics that such motivation is a powerful factor in language learning and in altering one's dialect. People shape their speech to be more like that of those around them when they want to bond with or win favor with people; they will not make changes if they do not care to associate with those around them or be accepted by them.

3. Influence of American English?

It is highly unlikely that Atta's L2 English dialect was impacted by his relatively short time in the U.S. (less than a year and a half) as an adult in his 30s. He is also reported to have kept to himself in the U.S. and so would not have had significant exposure to conversational American English or significant motivation to adapt his dialect.

4. Caribbean or African English influences?

To the best of my knowledge, there is no evidence that Atta spent any time in the Caribbean or in the presence of people from this area of the world, or that he spent any time in Africa other than his home country of Egypt.

5. Other language influences?

It is possible that Atta had other language influences than those in standard accounts of his life. For example, one alternative account indicates that a source purportedly close to Atta reported him as speaking French and Hebrew in addition to Arabic, German, and English; this source also reports him having attended private school in Lebanon.

6. Accent features of the AA11 voice

As described in detail above, the voice on the AA11 transmissions has features of L2 or L2-influenced English, but it is not German accented or French accented. These accents can include r-dropping in words like 'airport', but they would also be expected to include uvular /r/, pronounced far back in the throat, in words like 'everything', 'try', etc. Israeli English (influenced by L1 Hebrew) also typically has uvular /r/ (and sometimes trilled /r/) and in addition has other features not heard on the AA11 recording such as strong /h/ and final /k/ added to words ending in 'ing'.

There is no linguistic evidence that the voice on the AA11 audio represents Arabic English influenced by American English. Some of the non-trilled /r/ pronunciations sound like a native English retroflex or flapped /r/ (though most are unclear), but American English does not typically have r-dropping in words like 'airport' but instead has strongly pronounced retroflex /r/.

7. Summary conclusions regarding the AA11 accent vs. Atta's likely accent

If the voice in the AA11 transmissions is Atta's, then he likely would have had some linguistic influence other than what would be expected given what is generally known about

his background. It is unlikely he would have developed an idiosyncratic way of speaking English not based directly on his language influences, as people do not usually adopt dialect features for no reason.

It is also unlikely that the AA11 voice is that of another purported AA11 hijacker, all of whom were reportedly from Saudi Arabia and not very fluent in English. As indicated above, the AA11 voice is highly comprehensible to native speaker, which indicates fluency in English, and it lacks several features (including trilled /r/ and narrow intonation range) expected of the English accent of someone who is a native speaker of an Arabic language, including Saudi Arabian Arabic.

C. Accent and voice identification

1. Visual and social priming

It is well known in linguistics that people's perceptions of language can be influenced by visual and social priming. Research since at least the 1970s has shown that listeners may rate the same exact audio clip differently in terms of accentedness or standardness depending on what they are told about the voice (e.g. "This person is a janitor" vs. "This person is a lawyer") or the images they are shown (an African American face vs. a white face). Such effects also extend to native English speakers' tendency to hear non-native accents when they are not present when they are presented with 'foreign' faces. In addition, people even 'hear' specific sounds differently depending on cues. For example, a well-known experiment found that listeners reported hearing more Canadian-like vowels in words like 'out and about' when given a scoring sheet with 'Canadian' printed at the top; other listeners hearing the same recordings and marking responses on a sheet labeled 'Michigan' reported hearing more U.S.-like pronunciations.

Similarly, in another experiment in New Zealand, listeners in a room with a stuffed koala (associated with Australia) sitting in the corner reported hearing vowels that were more Australia-like than others in a room with a stuffed kiwi bird (associated with New Zealand), even though all of them were presented with the same audio stimuli.

Further, individual listeners listening to a single sound will perceive different sounds when the audio is accompanied by video of a person whose lips are making different sounds, showing how the visual channel can override the actual linguistic signal. (This is a well-known phenomenon in linguistics known as the McGurk Effect.)

It is no surprise that people listening to the AA11 audio who know its context (purported transmission from that plane on the morning of September 11, 2001) would hear an Arabic English accent, regardless of the actual pronunciation details of the voice. Then and now, people were primed to hear a certain accent by widespread accounts that the attackers were Arab terrorists, and so they heard an Arabic English dialect. This is exactly parallel to how participants in experiments report hearing different degrees of accentedness (even perceiving non-native accents when there are none) and different pronunciations for particular sounds when they are presented with different cues as to who the speakers are

(e.g. visual cues like faces, social cues such as a description of the speaker as 'working class' or of a particular ethnicity).

2. Shared features across dialects

Further, listeners have trouble accurately identifying dialect origins due to the nature of dialect variation itself. Accents and dialects are distinctive, not because of the presence or absence of any one feature, but because each has its own distinctive combination of features.

For example, as noted above, Arabic English shares monophthongization of the diphthongs [iɪ], [eɪ], [oʊ], and [uʊ] (i.e. the vowels in words like 'please', 'plane', 'okay', and 'move') with Caribbean English and African English varieties. However, it does not share the r-lessness typical of these varieties or their wide pitch range and sing-song intonation.

Similarly, a number of L2 and L2-influenced varieties are characterized by r-dropping in certain word positions (at the ends of words or in groups of consonants at the ends of words, e.g. 'port'), as are some native varieties, including even standard British English. These include varieties as wide-ranging as Bahamian English and Ghanaian English. Despite shared r-dropping, each of these dialects is different in terms of other features. For example, the 'uh' vowel in words like 'butter' is pronounced as 'better' in Ghanaian English but more like 'batter' or 'botter' in Nigerian English and Bahamian English; vowels before /r/ are pronounced differently in L2 varieties of English and native British English.

Because dialects are not composed solely of unique features but mix and match features found across varieties, it is often quite difficult for non-linguists to identify dialect origins, especially with limited language material, as in the present case.

3. Voice identification

A related consideration to accent identification is voice identification (also called speaker identification or earwitness identification): Could an individual who would have heard Atta's voice when speaking English confirm whether the AA11 voice is Atta's or not, regardless of whether they could accurately identify the dialect being spoken? Research on voice identification indicates that, in general, people are not very accurate in identifying individual voices, especially when there is a long delay between their exposure to the voice in question and the request for identification. Accuracy is further diminished by suggestive voice identification procedures, especially those involving one voice only rather than a properly constituted voice line-up (similar to eyewitness identification procedures involving visual line-ups).

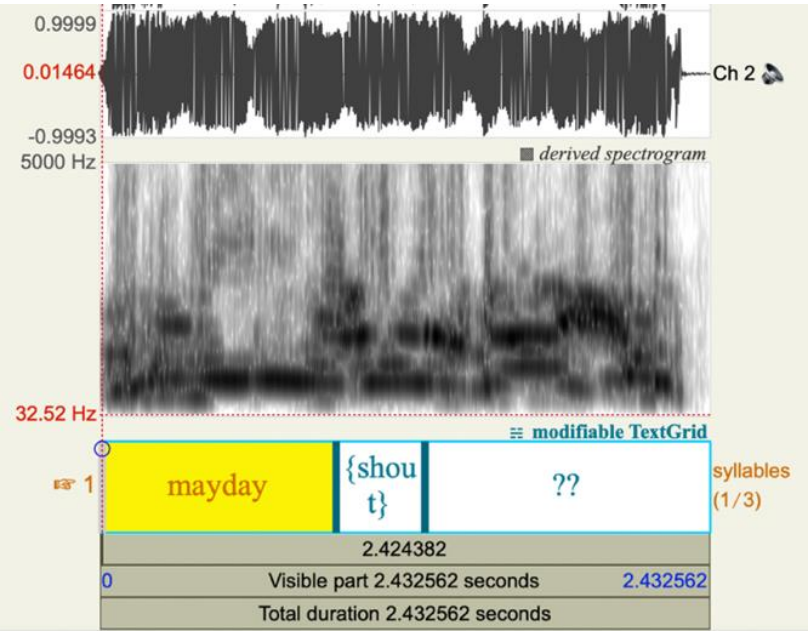
To the best of my knowledge, there are no reports of voice identification by people familiar with Atta's voice when speaking English that were made close to the 9/11 date or that were obtained via reliable voice identification procedures. In fact, there do not seem to have been any official attempts to formally identify the voice in the AA11 transmissions as Atta's; instead the voice has largely been presumed or attested to be his, without verification.

D. Linguistic analysis of ‘mayday’ portion of UA93 transmission (UA93-1)

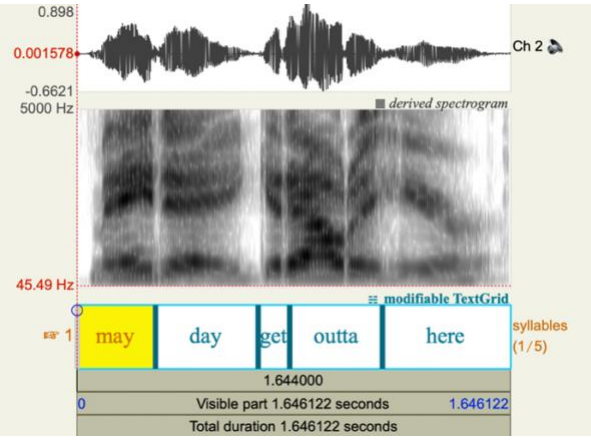
1. Linguistic considerations

It was represented to me that UA93-1 may consist of the words ‘Mayday! Get outta here’, spoken twice in rapid succession. Auditory and acoustic analysis of the UA93 transmission indicate that there is nothing inconsistent with this interpretation, though other interpretations are possible, for example, ‘Mayday! We’re gonna die here!’ A comparison of the second repetition of the unclear utterance from UA93 with clear utterances of each possible interpretation is presented below. The comparison shows consistency with either interpretation as well as the difficulty of obtaining a definitive interpretation of the noisy utterance. The difficulty is compounded by the emotionality of the utterance, which is shouted (even screamed) rather than uttered in a calm, clear tone:

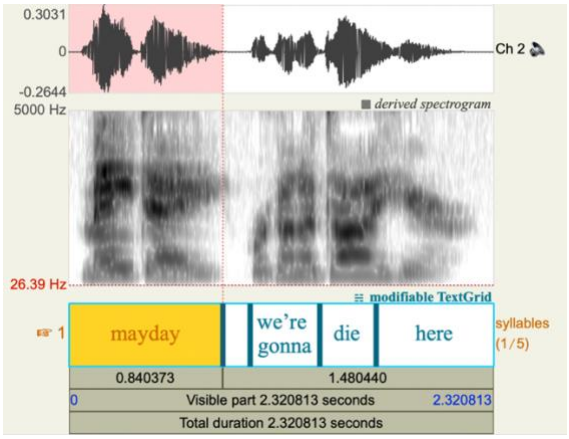
a. UA93-1, possible ‘Mayday! Get outta here!’ or ‘Mayday! We’re gonna die here!’:



b. Clear utterance of ‘Mayday! Get outta here!’



c. Clear utterance of ‘Mayday! We’re gonna die here!’:



2. Sociolinguistic and contextual issues

From the point of view of linguistic pragmatics (meaning in context), the interpretation in (c) above is more plausible: If the first word is ‘Mayday’, this indicates that the transmission is being directed to air traffic controllers, not the hijackers, and so it makes sense that the utterance following this call for help would be directed at ATC as well. ‘Get outta here!’ would seemingly be directed at hijackers invading the cockpit; ‘We’re gonna die here!’ is directed outward (though the pilot does not explicitly address ATC by stating the name of the station).

If the utterance in question is indeed an emotional call of ‘Mayday!’, followed by other emotional language, it raises questions from a sociolinguistic and pragmatic point of view. Highly skilled jobs like commercial airline pilot have much specialized vocabulary (jargon), as well as routine procedures specialists are trained to follow in a wide range of circumstances (i.e. interactional ‘scripts’ that must be followed). In fact, aviation communication is so highly routinized that is considered to be its own separate language variety, often called Aviation English. Investigators should consider whether the transmission of ‘Mayday!’ is aligned with the dictates of Aviation English, including standard procedure for alerting ground control of emergency situations such as hijacking. For example, in this case, the speaker cannot be heard to state the name of the addressed station or the aircraft ID, as would be expected in a distress situation, in which establishing communication with ATC is essential. Investigators will also want to consider whether the content and emotionality of the utterance aligns with what has been observed in pilots in previous life-threatening emergency situations, including hijackings and attempted hijackings.

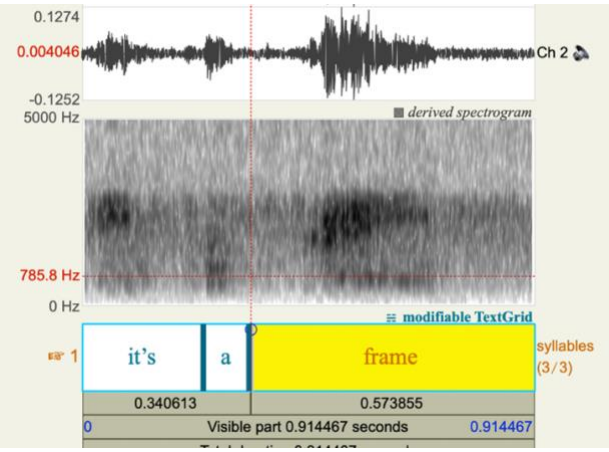
E. Linguistic analysis of whispered utterance at the end of CeeCee Lyles call

It was represented to me that the whispered utterance at the end of the Lyles call might be ‘It’s a frame’ or ‘You did great’. Auditory and acoustic analysis indicate consistency with ‘It’s

a frame' but less consistency with 'You did great'. The spectrogram in (a) below of the utterance in questions shows vowel formant frequency values (dark horizontal bands) consistent with the vowels 'ih' (as in 'it's'), 'uh' ('a'), and 'ey' (as in 'frame'), as indicated in the spectrogram of a clear utterance of 'it's a frame' in (b). They are less consistent with the vowels 'oo' and 'ih' in 'You did great', as shown in the comparative spectrogram in (c).

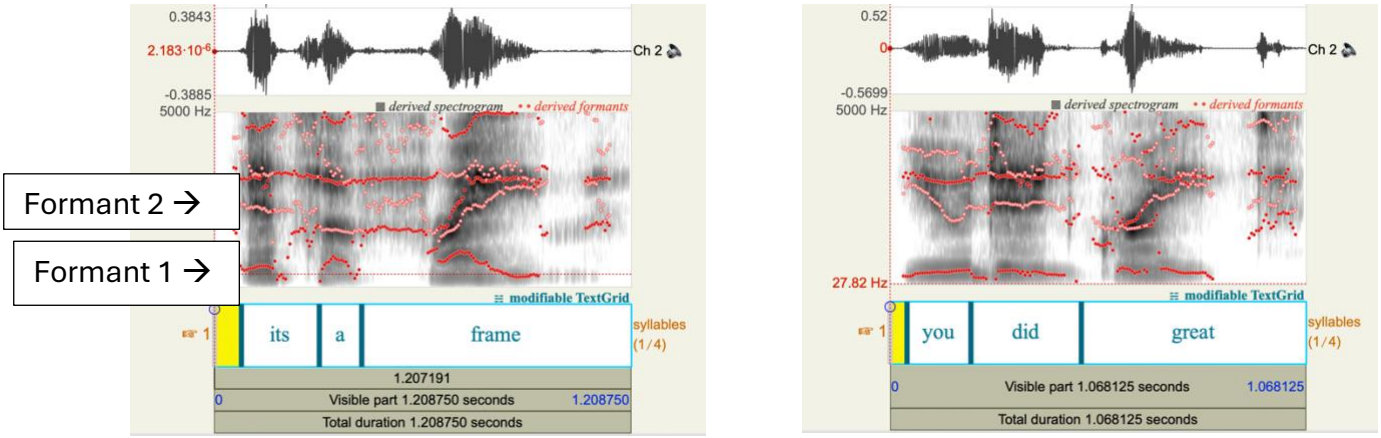
In the utterance 'it's a frame', the vowel in 'it's' has a low Formant 1 and high Formant 2 compared with 'a', which has a higher F1 and lower F2. In 'you did great', F1 remains steady, while F2 drops between 'y' and the following vowel and then rises for 'did'. ('Frame' and 'great' have the same vowel, and so their formant values are quite similar.)

a. CeeCee Lyles, possible 'it's a frame':



b. Clear utterance of 'it's a frame':

c. Clear utterance of 'you did great':



VI: OVERALL CONCLUSIONS

A. In sum, linguistic analysis of the AA11 transmissions purported to be by Mohamed Atta indicates a voice with some accent features found in a number of L2 and L2-influenced varieties of English, including Arabic English. However, this speaker does not exhibit the trilled /r/ that is typical (even stereotypical) of Arabic English but instead has r-

dropping. The speaker also has varied pitch, including 'sing-song' intonation, rather than the comparatively narrow pitch range typical for speakers of Arabic English. The UA93 speaker has an accent more characteristic of Arabic English, as his accent includes trilled /r/ and is relatively monotone. A comparison of the AA11 accent with several other L2 English varieties shows more similarity with Caribbean varieties than the others that were considered; however, the comparison was not exhaustive across world varieties of L2 English. Despite its L2 accent features, the AA11 voice is quite comprehensible to native English speakers, indicating fluency in English.

B. Atta's known language background suggests that he likely learned English from an early age and that the variety he acquired would have been Arabic English. It is possible that Atta's variety of English was idiosyncratic, but it is extremely unlikely that a native speaker of Arabic learning English in Egypt would have adopted a feature not typically found in Arabic English, r-lessness, and failed to adopt a very common feature found in the L2 English of speakers whose first language is Arabic, trilled /r/.

Atta also likely spoke German and has been reported to also have spoken French and Hebrew. However, given his reported self-isolation, it is not likely that he would have had enough exposure to the latter three languages or to their L2 varieties of English to have made a significant impact on his speech. He also likely would not have been motivated to alter his accent to conform to those around him. The AA11 voice does not have any obvious influence from German, French, or Hebrew, nor does it have the accent features typical of German-accented English, French-accented English, or Israeli-accented English.

If the AA11 voice is Atta's, he would have had some linguistic influence that would not be expected given what is generally known about his background. It is not likely that the AA11 voice is that of one of the other purported hijackers, since they were reportedly not fluent in English and since they too were native speakers of Arabic who would have been expected to have features like trilled /r/.

C. It is well-known in linguistics that people can be primed by visual and/or social cues to hear accents that are not present in the actual audio signal. Given that it is widely accepted that the 9/11 hijackers were Arab terrorists, it is not surprising that people believe they hear an Arabic English accent. This widespread belief should not be taken as proof that the accent identification is accurate.

Further, voice identification in this case is problematic as well. It was represented to me that there are no known voice identifications by people who would have been familiar with Atta's English-speaking voice that were made relatively close to the 9/11 date, without significant delay, or obtained via reliable voice identification procedures. In fact, to the best of my knowledge, there were no official attempts at formal identification of the AA11 voice; it was merely attested without verification to be Atta's.

To the best of my knowledge, there is no known audio of Atta's voice against which to compare the AA11 transmissions. Even if there were, comparative analysis may not be

determinative, as there currently exists no definitive 'voiceprint' technology, and the AA11 audio is of limited quantity and quality.

D. The analysis of UA93-1 ('Mayday! Get outta here!' or 'Mayday! We're gonna die here!') is inconclusive, due to very noisy audio and the fact that the words seem to be shouted or screamed rather than spoken calmly. Either of these interpretations raises questions from the point of view of linguistic pragmatics (meaning in context), and investigators should consider how hijacking emergencies are typically reported from the cockpit by trained pilots in terms of content and emotionality.

E. The analysis of the whispered utterance at the end of the CeeCee Lyles phone call is consistent with the interpretation 'It's a frame', but it is not definitive, due again to the fact that some of the audio signal is removed when voices are transmitted long-distance, via electronic means, and much of the signal is removed when utterances are whispered, leaving less acoustic material for analysis.

In closing, my expert opinion is that there is enough linguistic inconsistency between the AA11 voice and what would be expected of a typical speaker of Arabic English to merit further investigation into the source of the transmissions. Trilled /r/ in particular is a diagnostic feature of Arabic English but is lacking in this case. In addition, the use of two-part rather than one-part vowels in the r-less pronunciation of 'airport' (i.e. 'eh-uh' 'poo-ut' [ɛə puət]) also points away from an Arabic English dialect (as well as away from a German, French, or Israeli accent) and toward an L2 or L2-influenced English variety with diphthongs before dropped /r/, such as a Caribbean English dialect. Further, the intonation variation, at times 'sing-song' in character, is not typical of L2 English speakers whose native language is Arabic, who instead tend to have a narrower pitch range than native speakers of English. Rather, it is more typical of certain Caribbean English and African English varieties (though there is individually based intonation variation in all dialects).

A further possibility is that the accent in the AA11 transmissions is a disguise. Accurate dialect imitation is very difficult, and so it would not be surprising if someone attempting to mimic Arabic English would inadvertently fail to include prominent features like trilled /r/ and include extraneous features like r-lessness with glided vowels and sing-song intonation. It is also possible that the accent represents an attempt to put on generic 'foreign-accented English' by making use of features that are widespread in L2 varieties such as clipped vowels, stress shift, and r-lessness. It is not likely that the AA11 speaker is a native Arabic speaker attempting to mask his Arabic accent, as even highly fluent speakers have difficulty eliminating trilled /r/, even under the best of circumstances, and altering one's typical pronunciation features would be even more difficult under stress.