International Civil Aviation English Association | ICAEA Workshop 2018, Building on the ICAO LPRs – Communication as a Human Factor

May 10th, 3:10 PM - 4:10 PM

Intelligibility of American Aviation English Standard Phraseology

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intelligibility of American Aviation English standard phraseology

Julia Trippe, PhD

ICAEA Conference

May 10, 2018

ERAU, Daytona Beach

Aviation English

- international radiotelephony of pilots and air traffic controllers who do not share a first language
- codified jargon used by native English speaking (NES) and non-native English (EL2) speaking pilots and controllers
- used since 1951, required by ICAO since 2011
- standard phraseology as well as "plain English" (for non-routine transmissions)
  - "plain English" not defined

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what is AESP?

- designed for "maximum clarity, brevity and unambiguity [sic]"   (ICAO, 2007: 3.2.2.)

- word order and vocabulary are fixed

- only about 200 AESP words and phrases   (Tajima, 2004, p. 458)

- majority of ATCO/pilot communication

- ambient transmissions create situational awareness   (Prinzo & Campbell, 2008)

ATC AESP transmission:
two topics (heading and clearance)

"Pem thirty-four ninety-eight…"

ATC AESP transmission:
two topics (heading and clearance)

"Pem thirty-four ninety-eight, turn right heading two seven zero, runway two two right cleared for takeoff."

ICAO language proficiency requirements (LPRs)

- difficult to implement
  - no measurable proficiency goals
  - no common testing or training protocol (Prinzo, Hendrix, & Hendrix, 2008)
  - 'plain English' ability is not correlated with AE standard phraseology ability (Moder & Halleck, 2009)
    - AE language training for EL2 pilots focuses on standard conversational English (Estival & Molesworth, 2009; Estival, Farris, & Molesworth, 2016; ICAO, 2004)
    - NES pilots learn AESP "on the fly", while learning to fly

is AESP different than standard English (SE)?

- AE described as different register than SE (Bieswanger, 2016; Borowska, 2017; Moder & Halleck, 2009)

- attested differences

> constrained context, vocabulary and grammar
>
> minimal use of function words (prepositions, pronouns, articles)*
>
> rapid speech rate   monotone
>
> no face-to-face contact   noisy (static, multiple speakers)
>
>   (Hinrich, 2008; Moder, 2012; Philps, 1991)

* function words are typically reduced in SE (vowels are shortened and centralized)

AESP prosody

- AESP sounds different from SE ("machine gun-like")
  - different rhythm, stress and pause patterns than standard spoken Englishes (Estival & Molesworth, 2009; Prinzo, et al., 2008)

- lack of intonational and rhythmic changes that standard English speakers use to divide a speech stream into meaningful units (McMillan, 1998; Prinzo, et al., 2008)

- "the neutral prosodic contours and rapid delivery typically used by controllers may contribute to comprehension problems in radio communication for both native and non-native English speaking pilots" (Moder, 2012)

research questions

- does AESP actually have different sound patterns than SE?

- does standard English proficiency imply AESP proficiency?
  - is AESP intelligible to NESs?
  - is AESP intelligible to EL2 pilots?

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experiment 1: prosodic profile of AESP

analyzed 2 corpora (Godfrey, 1994):

- American English Radio broadcasters (SE)
- American English Air Traffic Controllers (ATC)
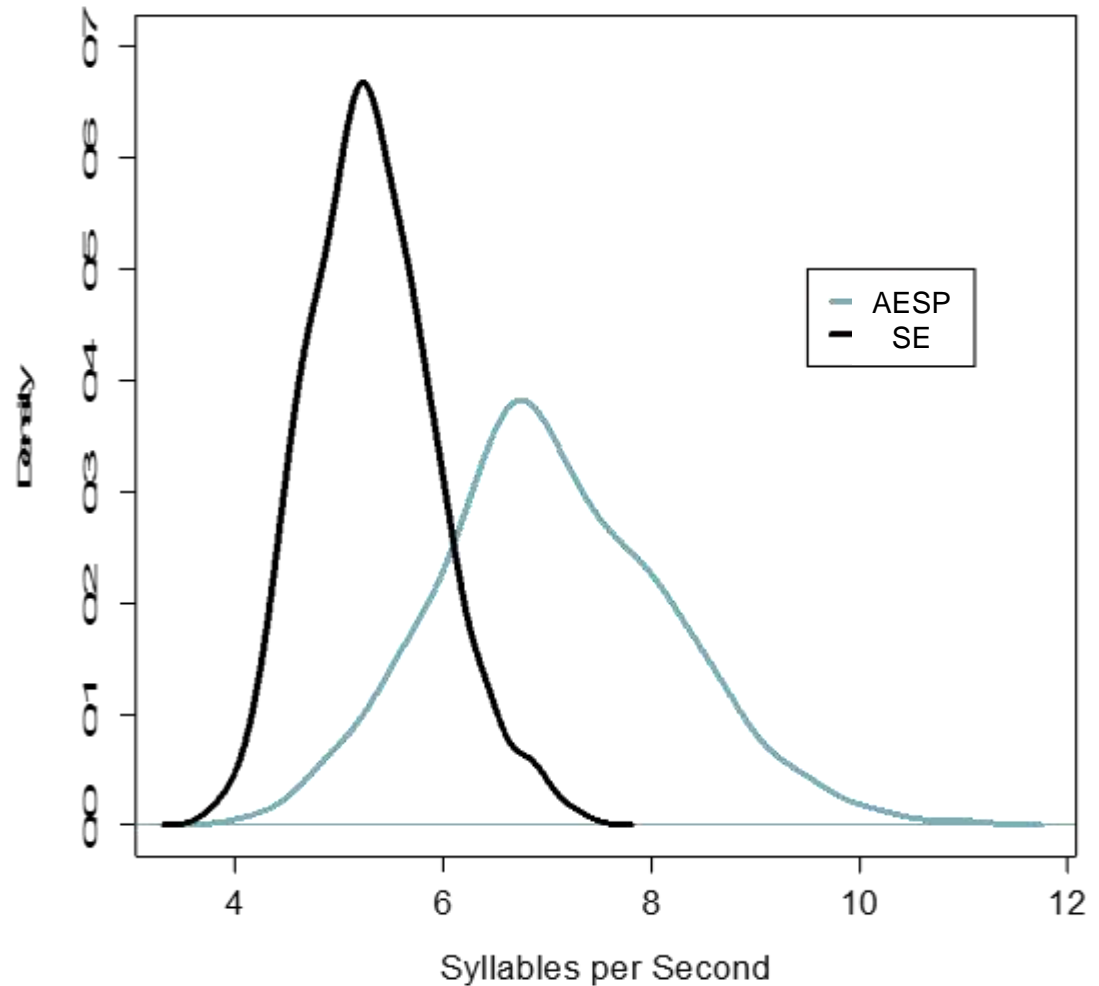
compared (Gorman, Howell, & Wagner, 2011):

- articulation rate (speech rate without pauses)
- intonation using pitch range
- rhythm using consonant and vowel interval durations

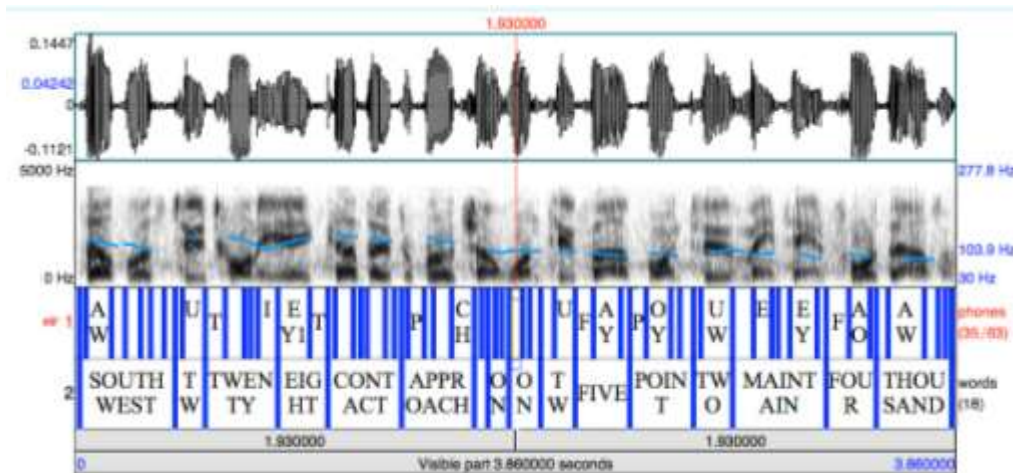# articulation rate results
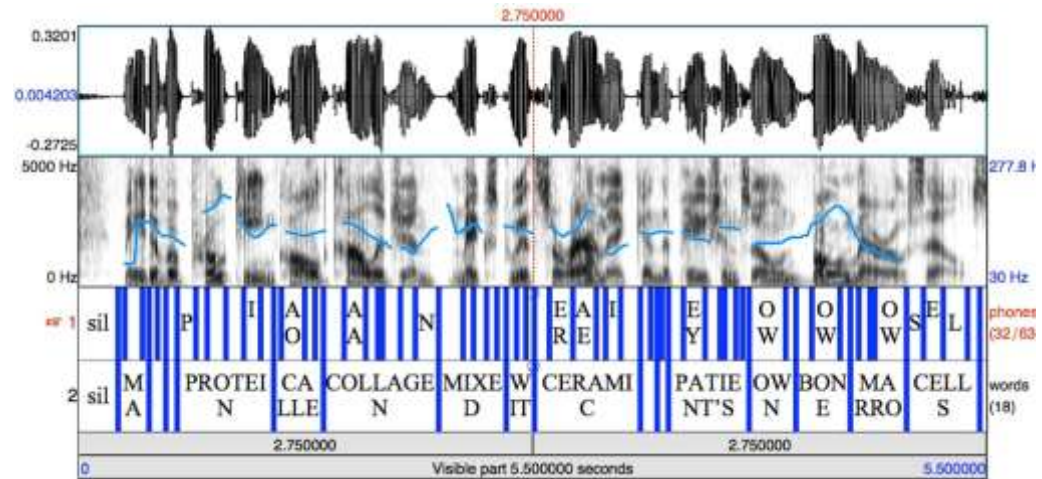
mean (SD)

AESP: 7.06 s/s (1.13)

SE: 5.22 s/s (0.72)
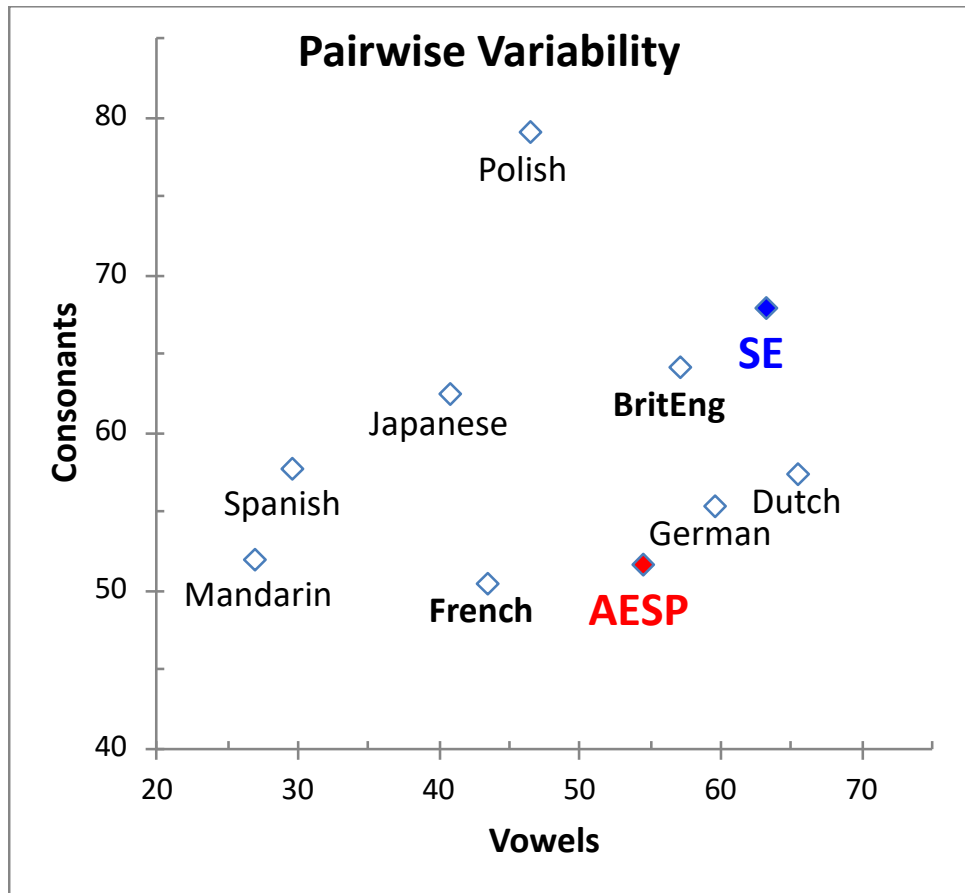
pitch range results: mean (SD)

Radio Broadcasters
133.06 Hertz (31.64)

Air Traffic Controllers
58.70 Hertz (21.04)

rhythm results
AESP and SE compared to other languages

differences in vowel and consonant durations are similar to distinct natural languages that are described as rhythmically different (e.g. French and English)

(Grabe & Low 2002, White &Mattys 2007)

results of first experiment

- AESP is speech rate is much faster than SE
  - multiple speakers
- AESP has flatter intonation than SE
  - monotone
    - due to speech rate AND
    - "neutral and calm" intonation (ICAO, 2010, 5.3.3.2.)
- AESP rhythm is different than SE
  - more like "machine gun-like"
    - due to fewer function words AND
    - speech rate AND
    - register effect

importance of language rhythm

- rhythm influences intelligibility (Tajima, Port, & Dalby, 1997)
- L2 rhythm is difficult to acquire (Aoyama & Guion, 2007; Guion, Flege, Liu, & Yeni-Komshian, 2000; Guion, Flege, Akahane-Yamada, & Pruitt, 2002)

- rhythm especially critical for intelligibility in AESP
  - in noise, higher level cues are not accessible (Smith, Cutler, Butterfield, & Nimmo-Smith, 1989, Mattys, White, & Melhorn, 2005)
  - speech in noise even harder for EL2 to access contextual cues (Bradlow & Alexander, 2007)

rhythm is a more critical cue to meaning in AESP because of the noisy signal, rapid speech rate, lack of intonation and lack of face-to-face communication

experiment 2: AESP intelligibility

- assumptions about intelligibility underlie current regulations and training
  - NESs are *not* specifically trained in AESP
  - EL2s are required to have SE proficiency
- given the prosodic differences discovered in the first study, AESP may not be intelligible to NESs
- does SE proficiency predict AESP proficiency?
  - Need to determine intelligibility of AESP to NESs and EL2s pilots and non-pilots

study participants

- 26 native English speaking non-pilot (NP) college students

- 23 native English speaking licensed pilots (EP)

- 29 Chinese licensed pilots (CP) training in USA

Table 1. Pilot population descriptives by group

	CP (n = 29)			EP (n = 23)		
	Range	*Mean*	*SD*	*Range*	*Mean*	*SD*
Age	22-26	23.38	1.08	19-55	28.30	7.77
TT	110-200	156.83	25.84	67-7000	1078.30	1767.40
IFR	10-66	37.21	14.79	23-55	301.65	620.96

study design

- AESP task*
  - repetition of 84 real air traffic controller transmissions
- standard English (SE) task*
  - repetition of 10 English sentences

  *scoring of intelligibility tasks: % words correct

- verbal working memory task
  - monosyllabic English word repetition with intervening judgment task

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sample study data

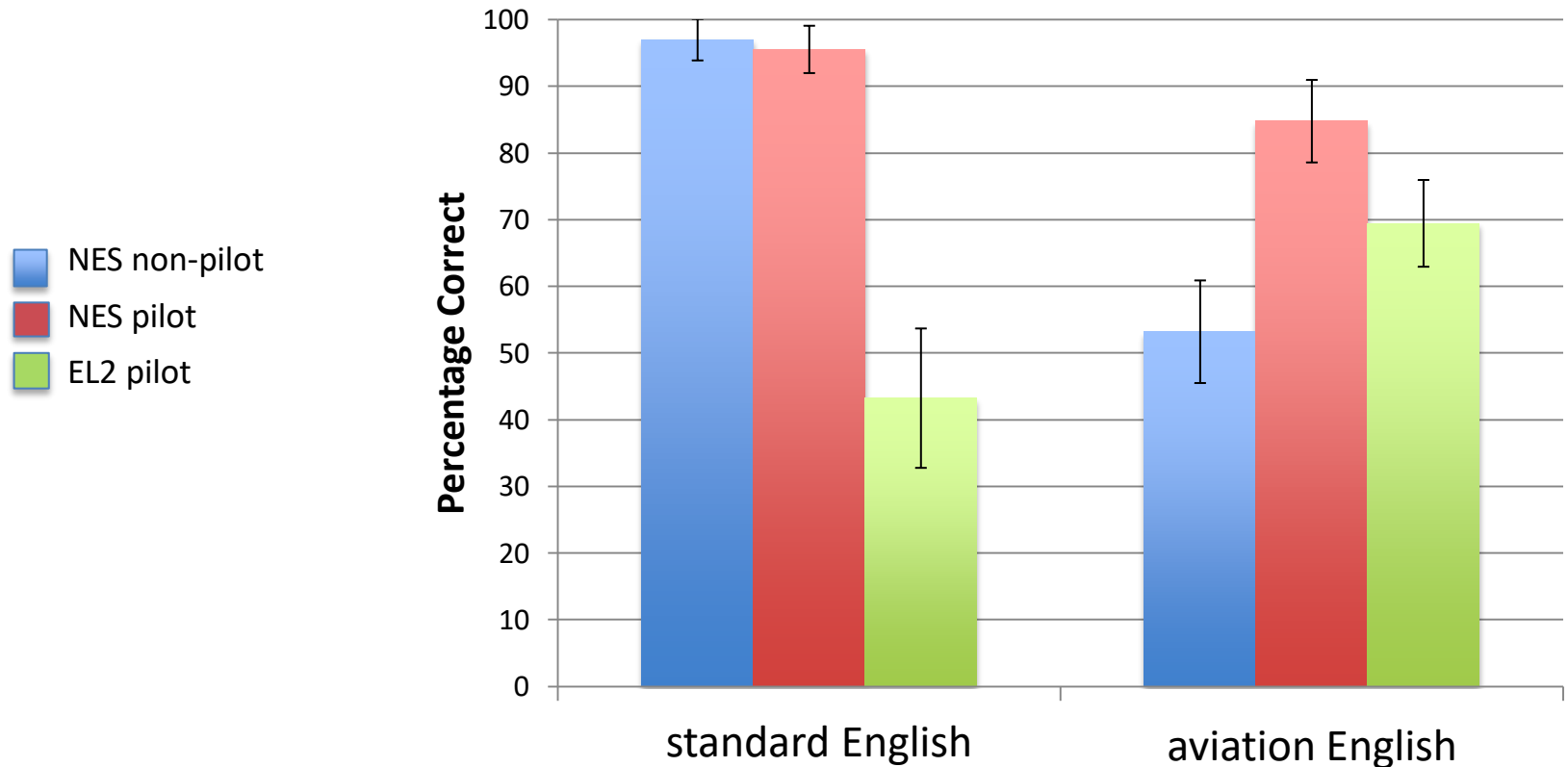NES ATCO transmission

NES non-pilot repetition

NES pilot repetition

EL2 pilot repetition

compiled intelligibility results

Note: whiskers signify standard deviations

AESP score analysis results*

- number of words had negative effect
  - for pilots, the word effect was mitigated by number of topics in the transmission (expert language users chunking language)

- for pilots only
  - flight experience had a positive effect
- for EL2 pilots only
 - SE/WM positive effect
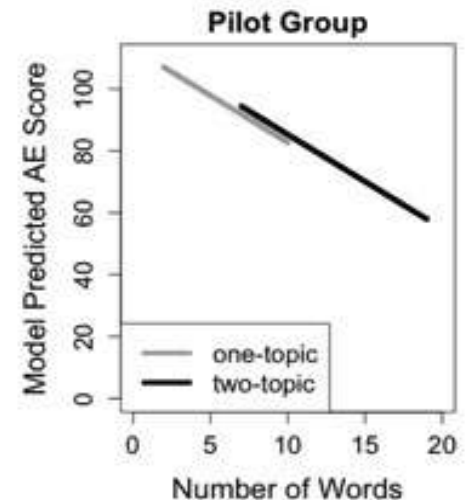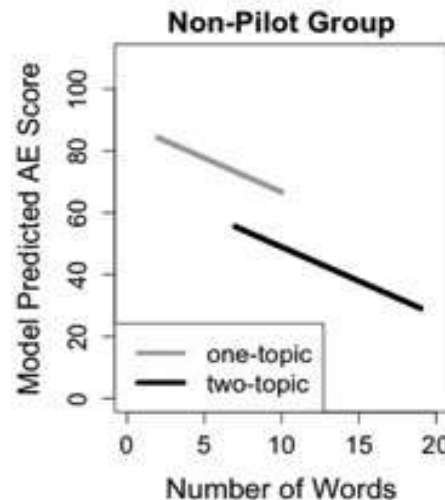
*- all results reported here reached significance of $p < .05$

error analysis

- numbers (43% of the words in the data)
  - more familiar to all subjects
    - for pilots: new information
    - BUT predictable due to limited selection

- (non-number) words (57% of the data)
  - for pilots: repetitive/predictable phrases in flight context
  - for non-pilots: less predictable

- mistakes
  - misheard, misremembered, made up
- omissions
  - unable to retrieve from memory
  - not heard
  - (for pilots) not required for AE standard phraseology

error analysis results
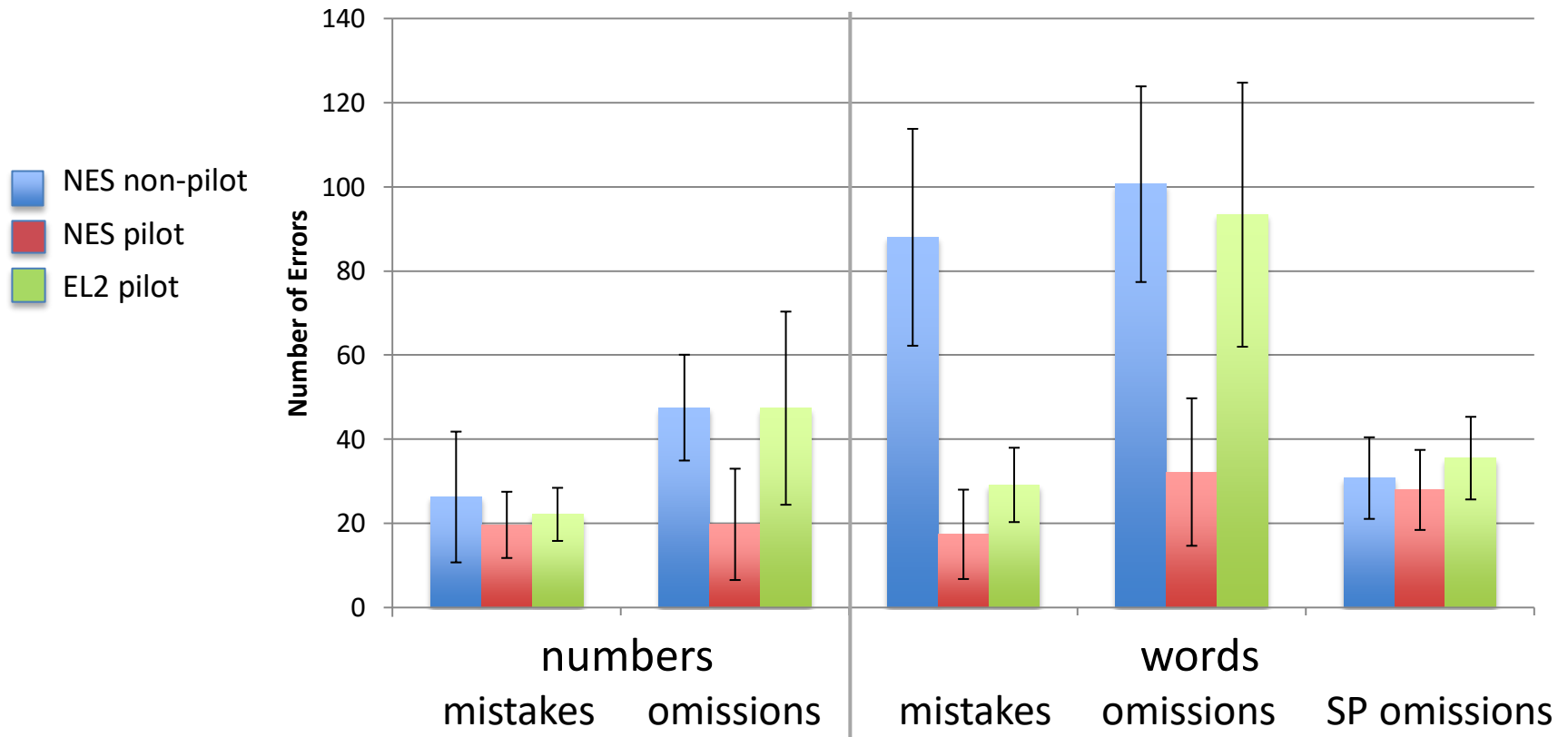
error analysis discussion

- NES non-pilots and EL2 pilots displayed similar patterns of word and number *omissions*

- EL2 pilots were less apt to make *word errors* than NES non-pilots
  - EL2 pilots have learned some AESP terminology

- AESP appears to be appropriately designed, given the number of omissions reflecting standard phraseology usage

experiment 2 summary

- aviation English is not intelligible to native English speakers

- standard English proficiency alone does not imply AESP proficiency

  - SE is not an appropriate metric by which to measure AESP ability

conclusions

- all pilots could use AESP training
  - AESP is distinct from SE
  - LPRs should require proficiency in AESP for all AE users
- AESP is learnable
  - higher time pilots had higher AESP proficiency
- AESP is teachable
  - constrained vocabulary and grammar
  - emphasize infrequent words/phrases
  - efficient, inexpensive ground training

considerations for training

- Both talker- and accent independent generalization occurs as a result of exposure to systematic variation during training (Baese-Berk, Bradlow, & Wright, 2013)

- Adaptation to foreign accented speech benefits from alternating active practice and passive exposure periods. If you are trying to produce something while you are trying to learn it, it really messes with your perception (Baese-Berk, 2010)

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The great enemy of communication,
we find, is the illusion of it.

--William Whyte, *Is Anybody Listening? 1950*

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Aviation English standard phraseology training workshop

Julia Trippe

ICAEA Conference

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2017 ICAEA attendees surveys

- discrepancies between (especially EL2) operators and non-operators opinions of the LPRs

- probably because LPRs do not address AESP
  - on the job needs of pilots and controllers (Kim & Elder, 2009)
  - NES pilots cite EL2 pilots' accented AE as source of miscommunications (Estival & Molesworth, 2009)
  - EL2 pilots and controllers cite NES pilots' use of 'plain English' as source of miscommunications (Kim & Elder, 2009)
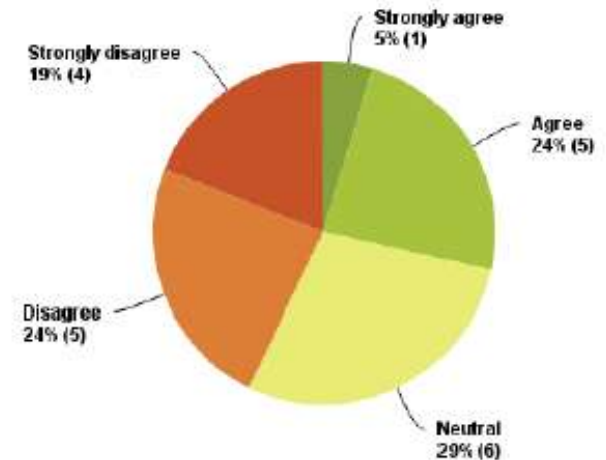
2017 ICAEA attendees survey results:

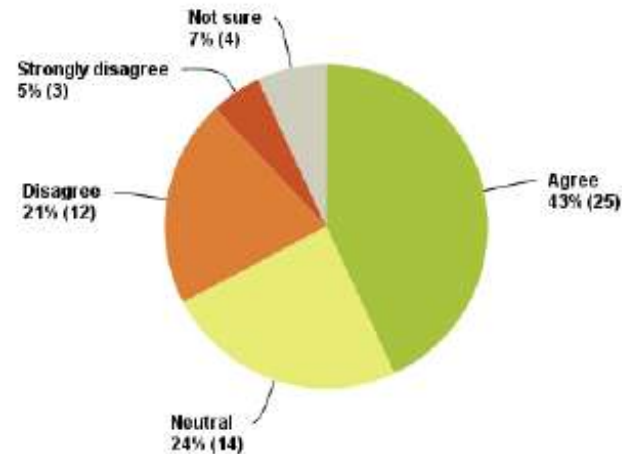# is AESP competency declining?

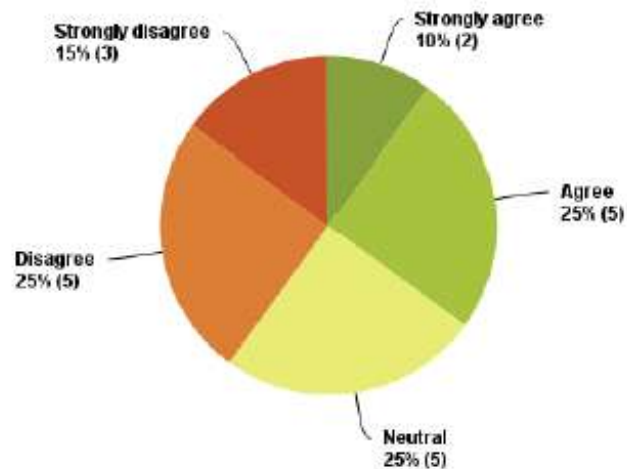non-operational
participants: NO
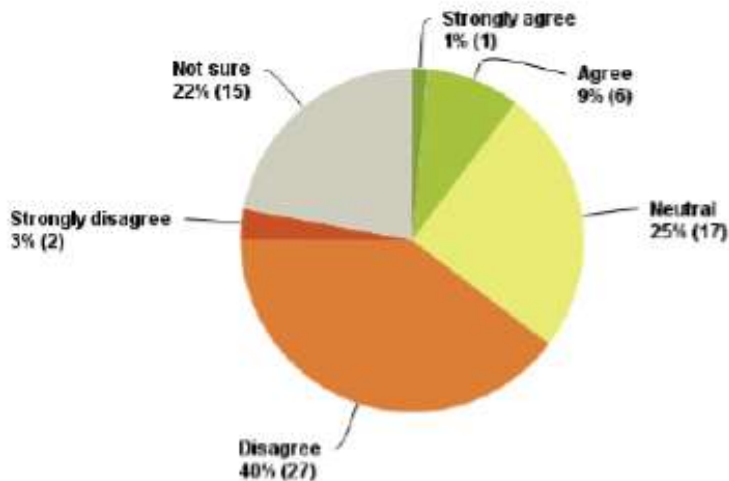
pilots and
ATCOs: YES

2017 ICAEA attendees survey results:
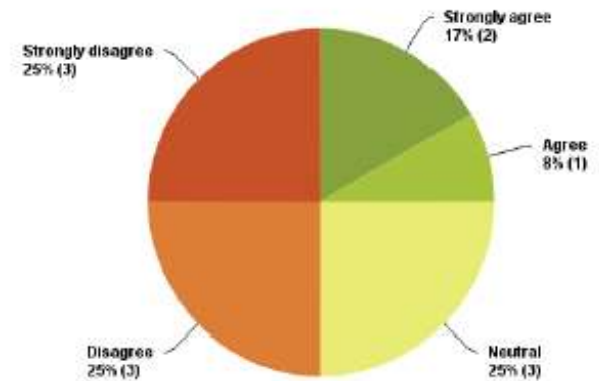
do tests assess communication needs?
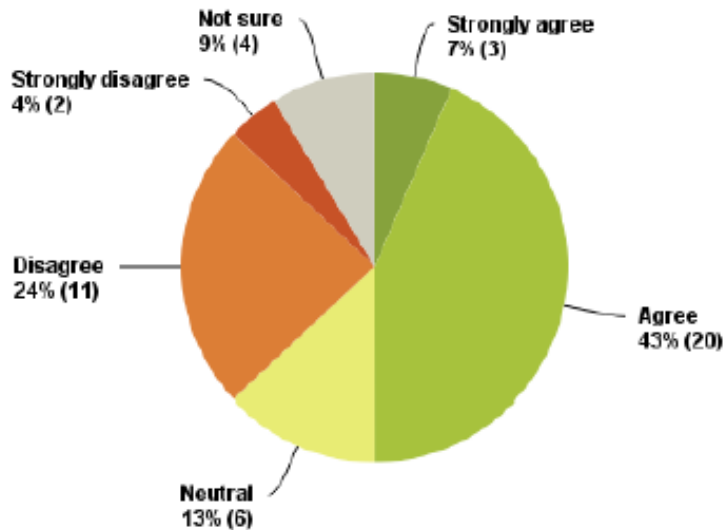
trainers and test developers AGREE!

pilots and ATCOs

EL2 pilots and ATCOs DISAGREE!

2017 ICAEA attendees survey results:

train to the test, not to proficiency?

language trainers and
curriculum developers
AGREE

EL2 pilots and
ATCOs
REALLY AGREE!

Not sure
9% (4)

Strongly agree
7% (3)

Strongly disagree
4% (2)

Disagree
24% (11)

Agree
43% (20)

Neutral
13% (6)

Disagree
17% (2)

Strongly agree
17% (2)
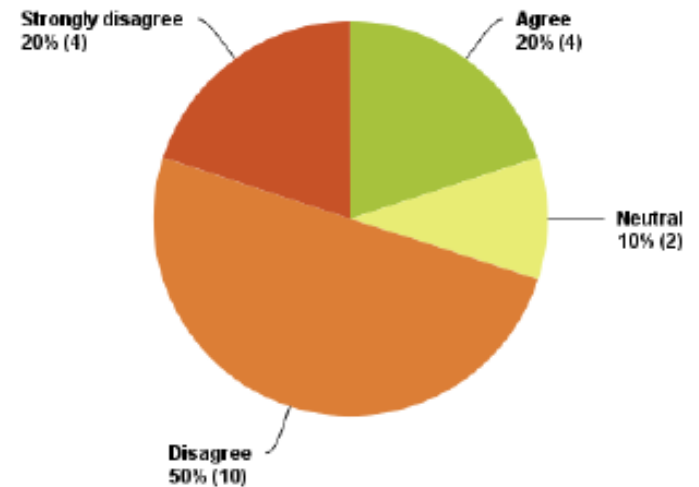
Neutral
8% (1)

Agree
58% (7)
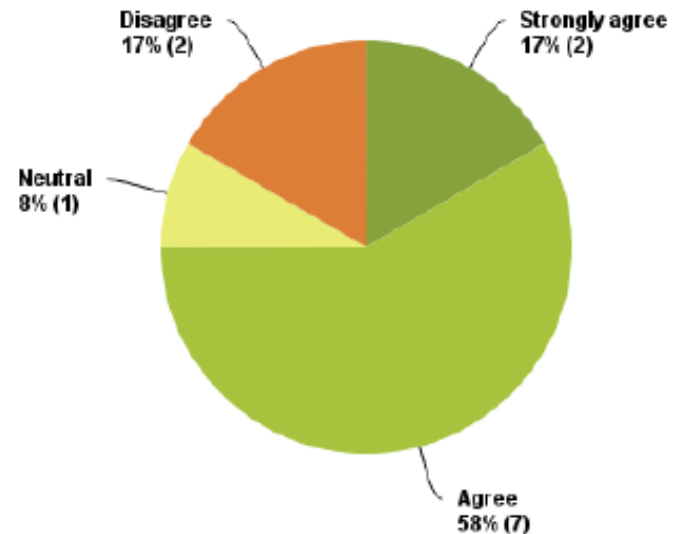
2017 ICAEA attendees survey results:

sufficient ongoing training?

language trainers and
curriculum developers
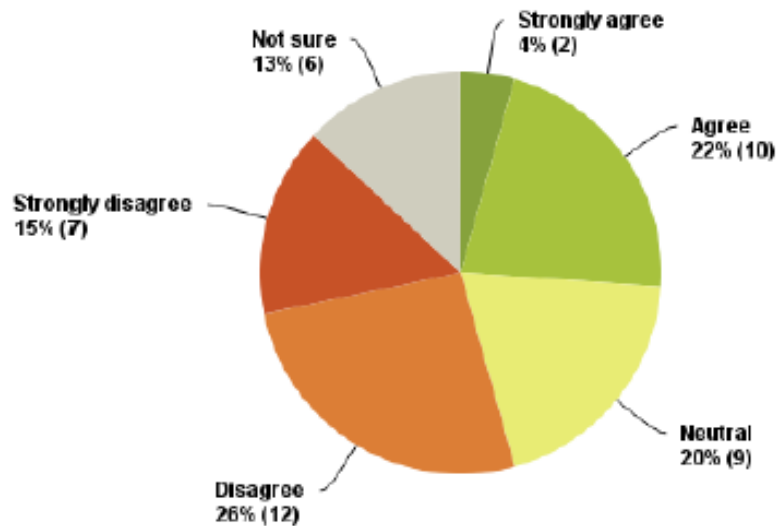
pilots and
ATCOs

2017 ICAEA attendees comments

- *you are talking about the pilots, not with the pilots!*

- *[standard] phraseology!!! who is looking after regular phraseology refreshers??*
- *standard phraseology is part of ATC communications and should therefore also be "re-checked" in native speakers*

- *new aviation English materials for trainings, especially materials for listening comprehension*
- *workshop sessions on developing language activities/tasks*

- *professional pilots/ATCs might bring out the most common/typical mistakes/difficulties/faux pas*
- *typical mistakes made by non-native and native speakers in their radio language and their ramifications*
- *linguist experts overvalue the technical aspects of English in comparison to the application*

wish list

- change the LPRs
  - require proficiency in AESP
    - for NESs and EL2s
  - establish measureable goals
- consistent training and testing internationally
  - same test, same requirements, same language
  - U.S. must comply: we train a lot of folks

developing AESP training

small group discussions
(one topic per group)

1. training design
2. feedback in training
3. testing design
4. production evaluation in testing
5. perception evaluation in testing

some of these areas overlap
try to stay focused on the main point

groups

at least one member from each profession:

- ATCO or pilot
- trainer/teacher
- regulator

- test developer
- curriculum developer
- evaluator

balance of NES and EL2

1. training design

- stimuli
- environment
- personnel
- levels of proficiency
- focus for NESs
- focus for EL2s

2. feedback in training

- intelligibility

- accuracy

- comprehension

- immediate v. delayed/compiled

- feedback display

3. testing design

- human v. computer
- personnel
  - experience
  - training
- scoring (measureable goals)
  - readback
  - actions
  - situational awareness

4. production (speaking) evaluation in testing

- intelligibility

- accuracy

- error analysis

- performance analysis

5. perception (listening) evaluation in testing

- readback accuracy

- proper actions

- accurate situational awareness

- error analysis

- performance analysis

discussion groups

1. training design
- stimuli
- environment
- personnel
- levels of proficiency
- focus for NESs
- focus for EL2s

2. feedback in training
- intelligibility
- accuracy
- comprehension
- immediate v. delayed
- feedback display

3. testing design
- human v. computer
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4. production evaluation in testing
- intelligibility
- accuracy
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5. perception evaluation in testing
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The great enemy of communication, we find, is the illusion of it.

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rhythm metric means*

metric	ATC	BUR
%V	43.84 (4.87)	41.86 (6.44)
VnPVI	54.58 (11.87)	63.21 (13.02)
VarcoV	57.99 (11.91)	61.89 (14.00)
ΔC	4.76 (1.37)	6.05 (1.61)
CrPVI	51.61 (15.29)	67.83 (19.75)
VarcoC	56.36 (10.49)	51.79 (10.48)

thank you!

see you next year

method

- aligned phonemes with orthographic transcription using Prosodylab Aligner (Gorman, et al., 2011)
- used Praat (Boersma & Weenink, 2013) scripts to extract vowel and consonant segments and calculate
- nPVI, rPVI, varcoV, varcoC, delta-C and %V

  – disfluencies deleted (Grabe & Low, 2002) to reflect natural production of target language
  – inter-pausal phrases only
  – included final syllables (Grabe & Low 2002; White & Mattys, 2007)

language related aviation accidents

- Tenerife 1977 both NNESs (583)
  - Pilot: "We are now at takeoff."
  - Controller: "OK. Stand by for takeoff. I call you." (Interrupted by another radio transmission)
- Everglades 1972 both NESs (99)
  - aircraft continued descending below their assigned altitude, the ATCO queried the crew by saying, "How are *things* comin' [sic] along out there?" To which the crew, who had just resolved a landing gear issue that had distracted them from altitude awareness stated, "*Okay*"
- New York 1991 (Avianca 52) NNES pilot - NES controller (72)
  - NNES pilot used ambiguous expressions like "need for priority," instead of clearly declaring "an emergency"
- Cali, Columbia 1995 NNES controller- NES pilot (163)
  - NNES ATCO said "their request made no sense... was illogical, incongruent, but I did not know how to convey those thoughts to the American flight crew...in English"

study participants

- 26 native English speaking non-pilots (NP) University of Oregon college students

- 23 native English speaking licensed pilots (EP) from Oregon flight school (students and instructors)

- 29 Chinese licensed pilots (CP) training in Oregon, USA

study design

- Aviation English task
  - repetition of 84 real air traffic controller transmissions
  - half and half, one and two aviation topics (i.e. altitude, heading, traffic, clearance, etc.)

- working memory task
  - monosyllabic English word repetition with intervening judgment task

- conversational English task
  - repetition of 10 English sentences
  - added noise to match AE sound files