Connected speech and syntactic impairment in Primary Progressive Aphasia

Presenter: Naida L. Graham PhD

Disclosure
Naida Graham

Relevant financial relationships

- Employed at the University of Toronto
- Received stipend from ASHA convention to cover costs of travel to this meeting
- The research was funded by a grant from the Canadian Institutes of Health Research (CIHR)

Relevant non-financial relationships

- Non-salaried member of Communication Research Team, Toronto Rehabilitation Institute

Outline of talk

- Diagnosis of PPA & its variants
- Description of connected speech in each variant
- Evaluation of connected speech in PPA
  - *Study 1:* Automated analyses of connected speech in PPA
  - *Study 2:* Evaluation of agrammatism in nonfluent variant
  - *Study 3:* Agrammatism in spoken vs. written production in nonfluent variant
- Conclusions

Diagnosis of PPA

Primary Progressive Aphasia (PPA)

Definition

A dementia in which language is the earliest and most severely affected aspect of cognitive functioning

Diagnostic Criteria

Gorno-Tempini et al (2011) Classification of primary progressive aphasia and its variants, Neurology, 76, 1006-1014

Diagnosis of PPA

- Insidious onset & gradual progression of language impairment (i.e., aphasia)
- Aphasia should initially be the most salient impairment and should be the main factor contributing to disruption of ADLs
- Diagnostic testing suggests a neurodegenerative process

Diagnosis of PPA – Exclusion criteria

- Pattern of deficits better accounted for by another disorder
- Prominent initial cognitive impairments outside the language domain (e.g., episodic memory, visuospatial skills)
- Prominent initial behavioural disturbance

Semantic variant

- Impairments in
    1) Naming
    2) Single word comprehension

- At least 3 of:
    1) Spared repetition
    2) Spared speech production with respect to grammar and motor speech
    3) Impaired object knowledge
    4) Surface dyslexia or dysgraphia

Nonfluent variant

- Must have at least 1 of the core features:
  - Agrammatism in language production
  - Effortful, halting speech with distortions & inconsistent speech sound errors (apraxia of speech)
- Must have at least 2 subsidiary features
  1) Impaired syntactic comprehension
  2) Spared single word comprehension
  3) Spared object knowledge

Logopenic variant

- Must have
  - Impaired single word retrieval
  - Impaired repetition of sentences and phrases

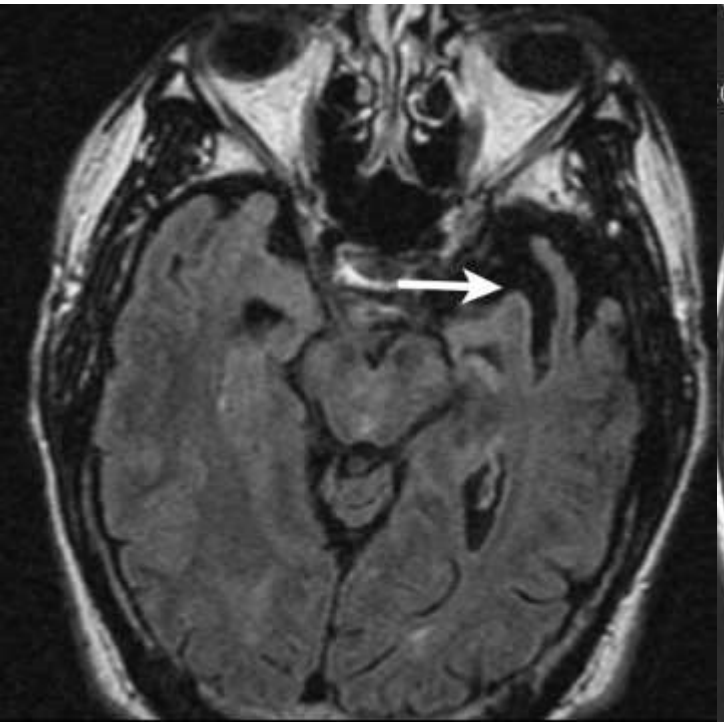
- Also, at least 3 of these features
  1) Spared motor speech
  2) Absence of frank agrammatism
  3) Spared single-word comprehension & object knowledge
  4) Phonological errors

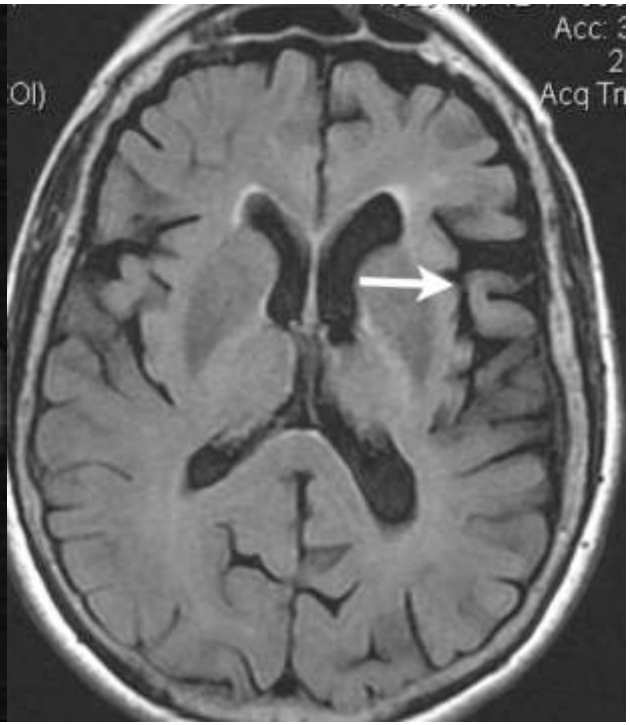
PPA variants – imaging-supported diagnosis

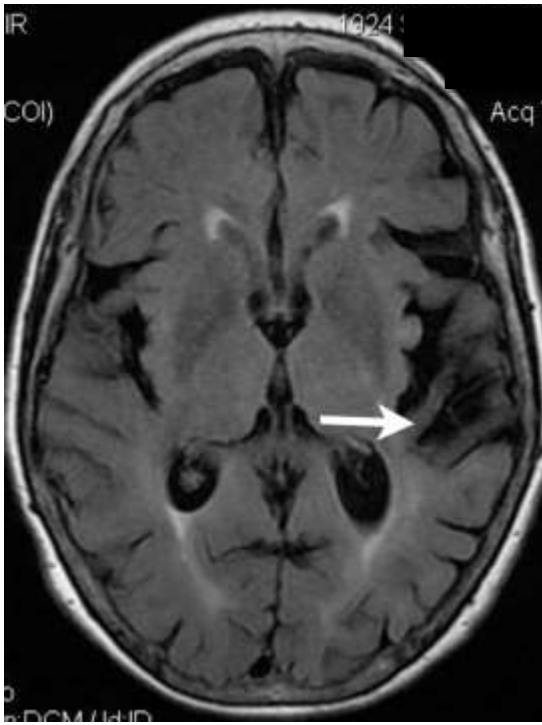
svPPA
Anterior temporal

nfPPA
Left posterior fronto-insular

lvPPA
Left posterior perisylvian or parietal







Description of connected speech in each variant

Speech in semantic variant – quantitative analyses

Strengths

- Normal rates of
  - –Syntactic errors (Wilson et al 2010; Sajjadi et al 2012)
  - –Phonological errors (Wilson et al 2010; Sajjadi et al 2012)
  - –False starts, filled pauses & repaired sequences (Wilson et al 2010)

Speech in semantic variant – quantitative analyses

Deficits (relative to controls)

- Reduced proportions of open class words (Garrard & Forsyth 2010; Wilson et al 2010; Ash et al 2013)
- Use general terms (Garrard & Forsyth 2010; Hoffman et al 2014)
- Use higher frequency & familiarity words (Bird et al 2000; Meteyard & Patterson 2009; Wilson et al 2010; Ash et al 2013; Fraser et al 2014; Mack et al 2015)
- Use more pronouns & more pronouns with ambiguous referents (Patterson & McDonald 2006; Kave et al 2007; Garrard & Forsyth 2010; Pakhomov et al 2010; Wilson et al 2010)

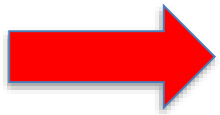
Speech in svPPA – **syntactic** skills

Strengths

- Rate of syntactic errors is no higher than controls (Wilson et al 2010; Sajjadi et al 2012)

Weaknesses

- Mean length of utterance is reduced (Wilson et al 2010)
- Speech is reduced in syntactic complexity (Patterson & McDonald 2006; Sajjadi et al 2012; Meteyard et al 2013)
- Patients rely on a restricted range of syntactic constructions (Patterson & McDonald 2006; Sajjadi et al 2012; Meteyard et al 2013)



Suggests mild expressive syntactic impairment

Speech in nonfluent variant – quantitative analyses

Deficits (relative to controls)

- Produce fewer words (Graham et al 2004; Wilson et al 2010)
- Use shorter utterances (Ash et al 2006, 2009; Thompson et al 2012)
- Speak more slowly (Rogers & Alarcon 1998; Graham et al 2004; Ash et al 2006; Knibb et al 2009; Wilson et al 2010)
- Produce more phonemic errors & distortions (Ash et al 2010; Sajjadi et al 2012; Ash et al 2013; Grossman et al 2013)

Broca's aphasia vs. nfPPA

- Early clinical descriptions suggested the language impairment in nfPPA parallels that seen in nonfluent stroke aphasia (Grossman et al 1996; Hodges & Patterson 1996; Snowden et al 1996; Mesulam 2003; Grossman & Ash 2004)

- Subsequent investigations have supported (Thompson et al 2013) and disputed (Patterson et al 2006) this idea

(Frank) agrammatism - definition

- Tendency to omit &/or substitute grammatical morphemes

  -> syntactic errors

- Reductions in:

  - Syntactic complexity
  - Proportion of verbs
  - Proportion of closed-class words

Saffran et al 1989; Thompson & Bastiaanse 2012; Wilson et al 2012

Speech in nfPPA – syntactic skills

Deficits (relative to controls)

- Fewer complex grammatical structures (Graham et al 2004; Ash et al 2009, 2010, 2013; Knibb et al 2009; Wilson et al 2010)
- Fewer well-formed sentences (Ash et al 2010, 2013; Grossman et al 2013; Thompson et al 2013; Mack et al 2015)
- More grammatical errors (Knibb et al 2009; Ash et al 2010; Wilson et al 2010; Sajjadi et al 2012)

Speech in nfPPA – syntactic skills

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- More grammatical errors (Knibb et al 2009; Ash et al 2010; Wilson et al 2010; Sajjadi et al 2012)

In contrast

- Normal rates of grammatical errors, or errors made only by a minority of patients (Graham et al 2004; Clark et al 2005; Knibb et al 2006; Silveri et al 2014)

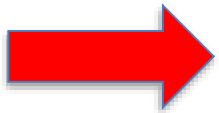
Lack of frank agrammatism in nfPPA

- Speech of patients with nfPPA may include *normal* proportions of
  - **Verbs** (Graham et al 2004; Kibb et al 2009; Thompson et al 2012, 2013; Fraser et al 2014; Mack et al 2015)
  - **Closed class words** (Sajjadi et al 2012; Thompson et al 2012, 2013)
- But other studies have found contradictory results (Ash et al 2009, 2010; Wilson et al 2010)

Grammatical skills in nfPPA

- Features of frank agrammatism are inconsistently documented in group studies of nfPPA

- When features of agrammatism are documented, there may be individuals whose results do not follow the group pattern



Across patients, there is a high degree of variability in grammatical skills

Speech in lvPPA– quantitative analyses

Signs of dysfluency

- Speech rate is slower than controls (Wilson et al 2010; Thompson et al 2012, 2013; Ash et al 2013)
- High rate of pauses (Wilson et al 2010 ; Ash et al 2013, Teichmann et al 2013)
- False starts & hesitations/filled pauses (Wilson et al 2010; Ash et al 2013)
- Increased number of repaired sequences (Wilson et al 2010)

Speech in lvPPA– quantitative analyses

Signs of word finding impairment

- Pauses occur especially before nouns (Mack et al 2015, Teichmann et al 2013)
- Increased number of pronouns (Wilson et al 2010)
- Reduced proportion open class words (Ash et al 2013)

At the single word level

- Phonological errors in some patients (Wilson et al 2010)
- Well articulated, no distortions (Wilson et al 2010)

Syntactic production in lvPPA

- Reduced mean length of utterance (Wilson et al 2010; Thompson et al 2012)
- Proportion of grammatical sentences is lower than controls, but higher than nfPPA (Thompson et al 2012; Ash et al 2013)
- Increased syntactic errors, but attributed to constant re-wordings (Wilson et al 2010)

Syntactic production in lvPPA

Is there a syntactic impairment?

- Yes, but mild & in a minority of patients (Teichmann et al 2013)
- No (Thompson et al 2013) – but part of diagnosis of lvPPA was that patients passed a syntactic production test

Study 1: Automated analyses of connected speech in PPA

Study 1 – automated analyses of narrative speech in nfPPA & svPPA

- **Task:** recounting Cinderella story
- **Participants:** 10 svPPA, 14 nfPPA, 16 controls
- **Method:**

  Using computational techniques,

  syntactic & semantic features

  were automatically extracted from transcriptions of narrative speech

Fraser, Meltzer, Graham, Leonard, Hirst, Black & Rochon (2014) Automated classification of primary progressive aphasia subtypes from narrative speech transcripts. Cortex, 55, 43-60.

Automatically extracted features

12 part-of-speech features

e.g. Nouns Adjectives

Verbs Pronouns

26 complexity features

e.g. Mean length of:

sentence, clause, T-unit

Coordinate conjunctions

Parse tree height

Automatically extracted features

5 fluency features

e.g. Word length Speech rate

Total words Um, uh

11 psycholinguistic features

e.g. Frequency Familiarty

Age-of-acquisition Light verbs

Results - Features that best distinguished svPPA & Controls

Elevated in svPPA

Frequency
Familiarity
Demonstrative pronouns
Clauses

} esp nouns

Reduced in svPPA

Nouns
Noun:verb ratio
Word length
Clause length

Features that best distinguished nfPPA & Controls

Elevated in nfPPA

Frequency – esp verbs

Reduced in nfPPA

Speech rate

Word length

Study 1 – summary – relative to controls

svPPA & nfPPA

- used words that were higher in frequency, especially nouns for svPPA & verbs for nfPPA

svPPA

- used words which were higher in familiarity
- produced fewer nouns but more demonstratives

nfPPA

- had slower speech & used shorter words

Study 1 - comment

Surprisingly

None of the grammatical features distinguished nfPPA from controls

Study 2: Evaluation of agrammatism in nonfluent variant PPA

Potential reasons for variability in grammatical skills in nfPPA

- Studies include variable numbers of patients whose dysfluency arises from a motor speech impairment

- Difficulty distinguishing nonfluent & logopenic variants

Potential reasons for variability in grammatical skills in nfPPA

- Studies include variable numbers of patients whose dysfluency arises from a motor speech impairment – Addressed this by evaluating motor speech skills in our PPA patients

- Difficulty distinguishing nonfluent & logopenic variants – Addressed this using volumetric MRI data to provide unbiased imaging-supported diagnosis

Study 2 – Evaluation of agrammatism in nfPPA

- **Background** – Inconsistent results in the literature with respect to grammatical skills in nfPPA

- **Aim** – To examine syntactic production in nfPPA patients with
  - Preserved motor speech skills
  - Diagnosis independently supported by volumetric MRI data

- **Participants** - 14 nfPPA, 14 svPPA, 4 lvPPA

Graham, Leonard, Tang-Wai, Black, Chow, Scott, McNeely, Masellis & Rochon, submitted

Study 2: grammatical production & motor speech skills

Blinded expert raters evaluated speech samples for features of agrammatism & AOS

- Narratives
  - Topic-directed interviews (Orange et al 1998)
- Tasks sensitive to apraxia of speech (Duffy, 2013)
  - Repetition of words of increasing length
  - Repetition of polysyllabic words/phrases 3X
  - Diadochokinesis (Puh-tuh-kuh)

Agrammatism checklist – example features

- Lack of functor/closed class words (articles, prepositions, etc.)
- Omission/substitution of inflectional affixes
- “Sentences” are simple & incomplete
- Limited variety of sentence structure

Based on Saffran et al 1980

Apraxia of speech checklist – example features

- Syllable segregation
- Phonemic anticipatory, perseverative or transposition errors
- Intrusion of schwa between syllables or in consonant clusters
- Visible/audible searching (articulatory groping)

Based on Dabul et al 2000; Duffy 2013

Study 2 – methods for imaging analyses

- Analyzed regions of interest (all left-sided)

Inferior frontal } nfPPA
Insula
Anterior temporal - svPPA
Inferior parietal } lvPPA
Posterior temporal

- Atrophy scores were calculated for each individual for each brain region (accounted for variation in brain/head size)

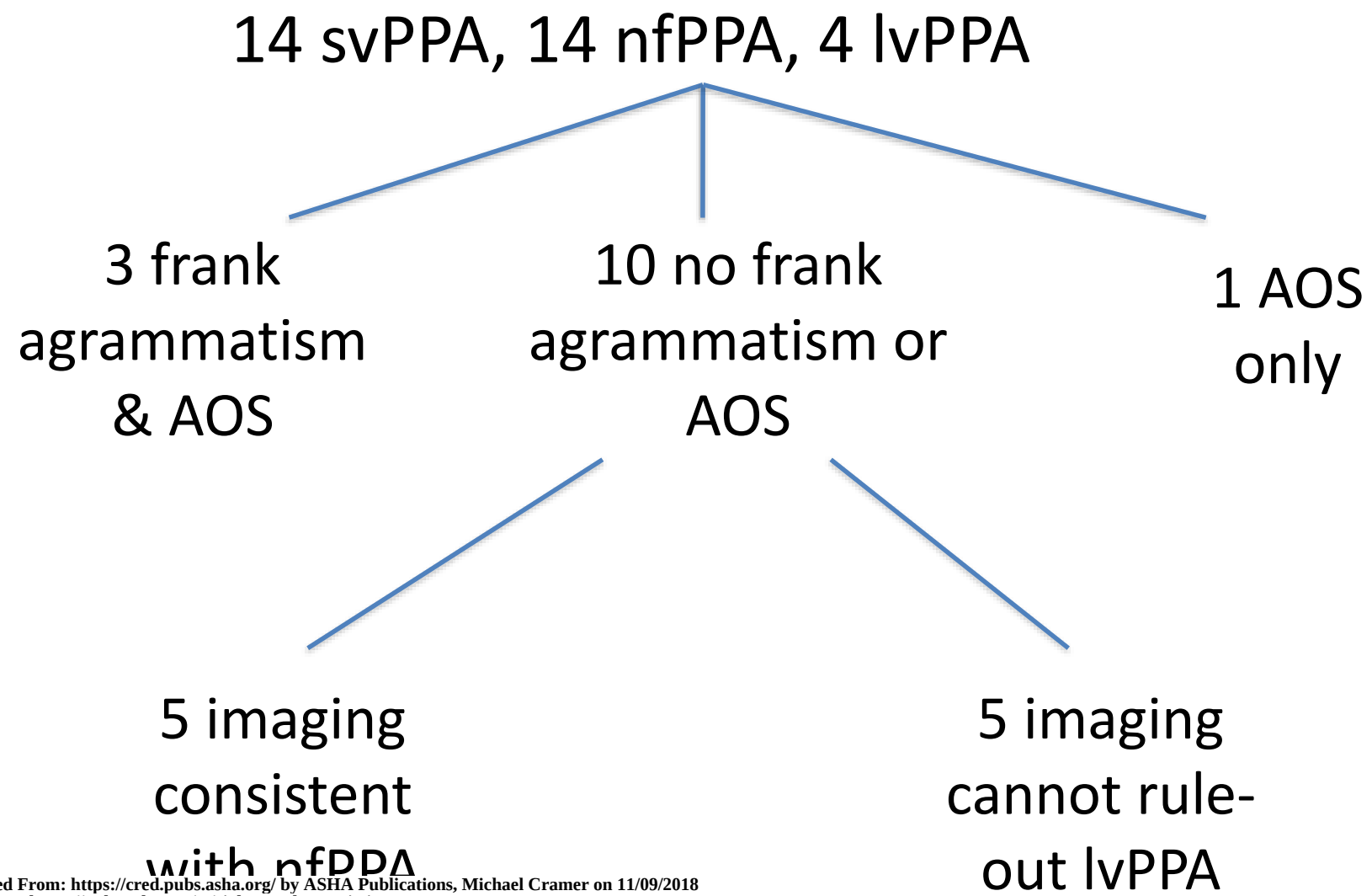
Study 2 – methods for imaging analyses

Criteria for imaging supported diagnosis of nfPPA

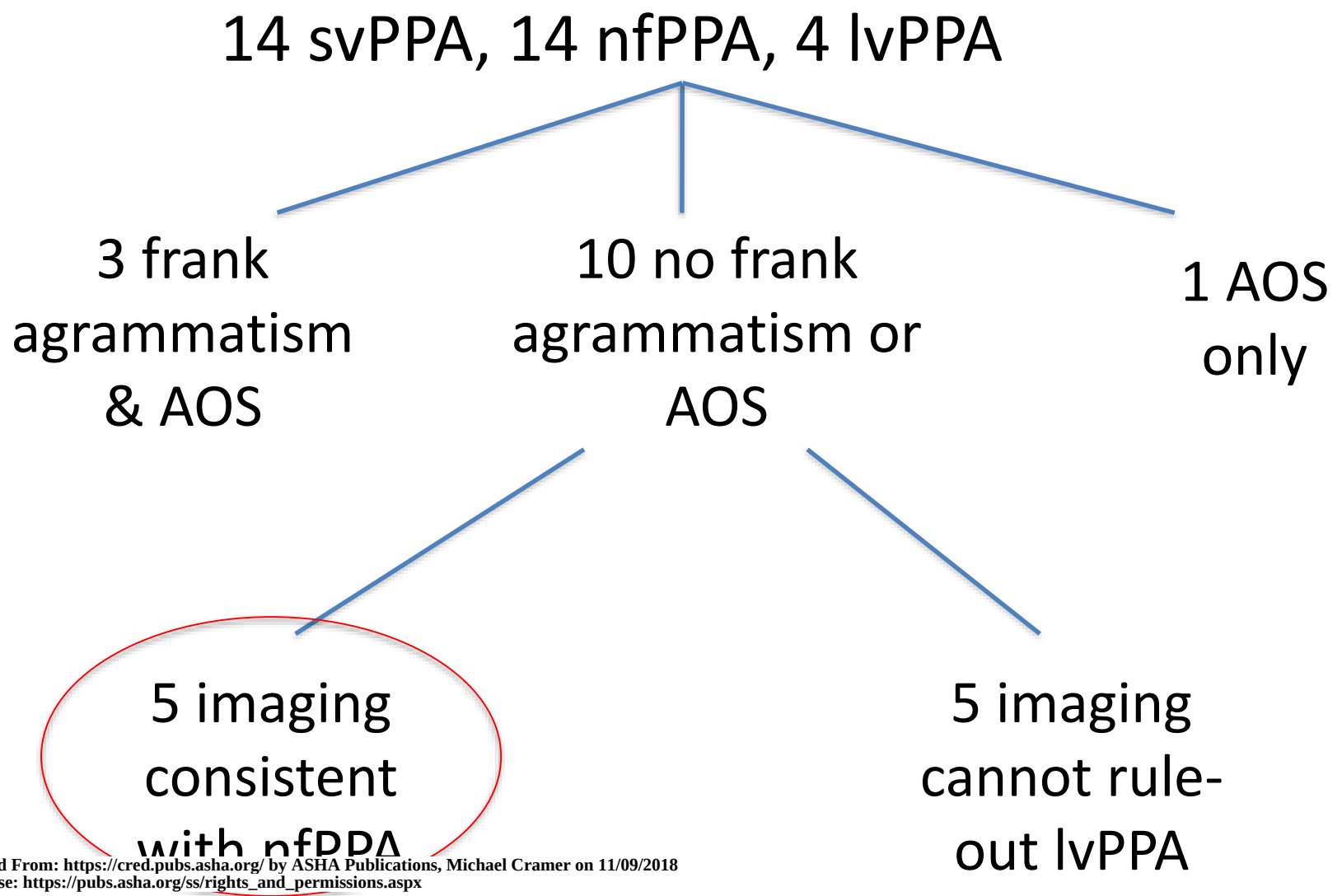
Atrophy scores were:

- Abnormal in insula &/or inferior frontal
- Normal in inferior parietal & posterior temporal

Study 2 - results



Study 2 - results



Transcription of nfPPA patient

- Examiner: Tell me about what you do each day

- Patient: I read a lot, and uh, I look at television here and there, and uh, then, I do go out . . . I don't do very much, really, uh, I go visiting and have an odd person in to have a cup of tea and uh, then on the weekends I go out with my family

Study 2 – Stage of illness

- Symptom duration:

  Range 1.7 – 6.2 years, mean = 3.5 years

- Some of the patients were beyond the earliest stages of illness

Do nfPPA patients exhibit frank agrammatism?

The main finding – Some nfPPA patients had

✓ Imaging-supported diagnosis

✗ Frank agrammatism in speech

✗ Apraxia of speech

Study 2 - Implications

Differentiation of nfPPA & lvPPA

- Some researchers classify as lvPPA patients whose speech is nonfluent but without frank agrammatism or AOS
- The present results suggest this would lead to misclassification in some cases

Agrammatism in production in nfPPA

- May be difficult to detect in the clinic because in some patients it may be subtle

Study 3: Agrammatism in spoken vs. written production in nfPPA

Study 3 – Agrammatism in spoken vs. written production in nfPPA

- 14 nfPPA, 11 controls
- Study was done prior to current diagnostic criteria. At least 12 patients are unlikely to have lvPPA (9 had imaging with predominant left frontal/insular abnormality; 4 developed CBS)
- Written & spoken descriptions of cookie theft picture

Graham, Patterson & Hodges (2004) When more yields less: Speaking & writing deficits in nonfluent progressive aphasia, Neurocase, 10, 141-155

Study 3 - Results

- Spoken picture description - nfPPA patients had normal
  - Noun:verb ratios
  - Content:function word ratios
  - Rates of syntactic errors

- Written picture description
  - Same results except produced more syntactic errors than controls

Study 3 - Implications

- Once again, results suggest that some nfPPA patients do not have frank agrammatism

- Agrammatism may be apparent in writing before it is noticeable in spoken language

Final comment & conclusions

Final comment - Methods of assessing grammatical skills in speech

- Make a sentence test (Billette et al 2015, in Aphasiology)
  - Emma bake pie party -> Emma baked a pie for the party

- Progressive aphasia language scale (Leyton et al 2011, in Brain) & Progressive aphasia severity scale (Sapolsky et al 2014, in Aphasiology)
  - Provide ratings for severity of impairment in grammatical production & morphology

Conclusions

svPPA - There is evidence that grammatical production is simplified, although without errors

nfPPA - There is a high degree of variability across patients with respect to grammatical skills

lvPPA - Some patients may exhibit grammatical dysfunction, but the impairment is usually mild and occurs in a minority of patients

Collaborators

In Toronto, Canada:

Elizabeth Rochon

Sandra Black

Carol Leonard

Tiffany Chow

Alicia McNeeley

Graeme Hirst

David Tang-Wai

Katie Fraser

Chris Scott

Mario Masellis

Jed Meltzer

In Cambridge, UK (Study 3):

John Hodges

Karalyn Patterson