Natural Language Processing and Language Disabilities

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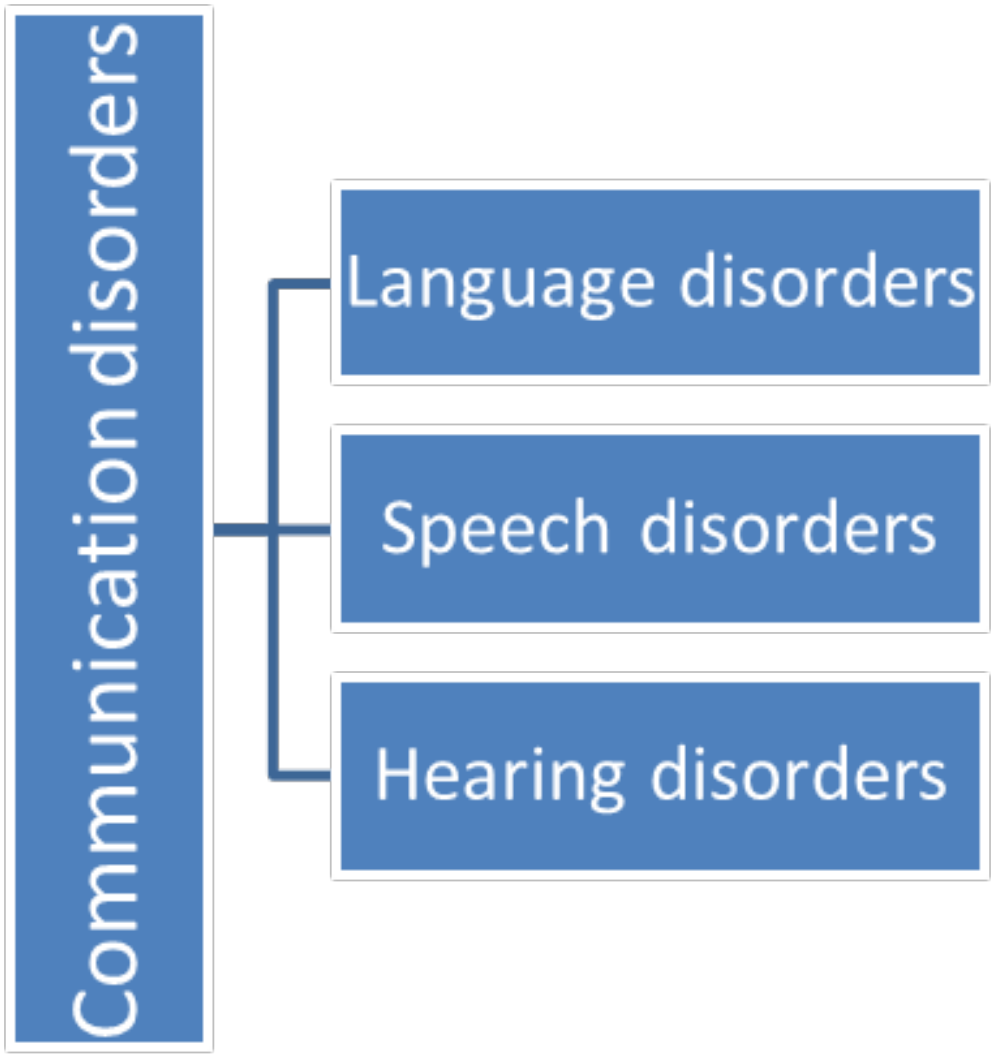
Part I: Language Disabilities

- 1. Language disabilities
- 2. NLP for language disabilities
- 3. FIRST (Flexible Interactive Reading Support Tool): overview
- 4. FIRST: what we have done so far
- 5. FIRST: upcoming work
- 6. Related on-going and forthcoming research

Language Disorders



Language Disorders

Problems experienced could involve:

- grammar (syntax and/or morphology)
- semantics (meaning)
- other aspects of language

Problems may be:

- receptive (impaired language comprehension)
- expressive (language production)
- a combination of both

Types of Language Disorders

Language disorders classified as either developmental or acquired:

- Developmental language disorders: in children who do not develop functional language skills
- Acquired language disorders (aphasias): language impairments caused by damage to areas of brain responsible for language function

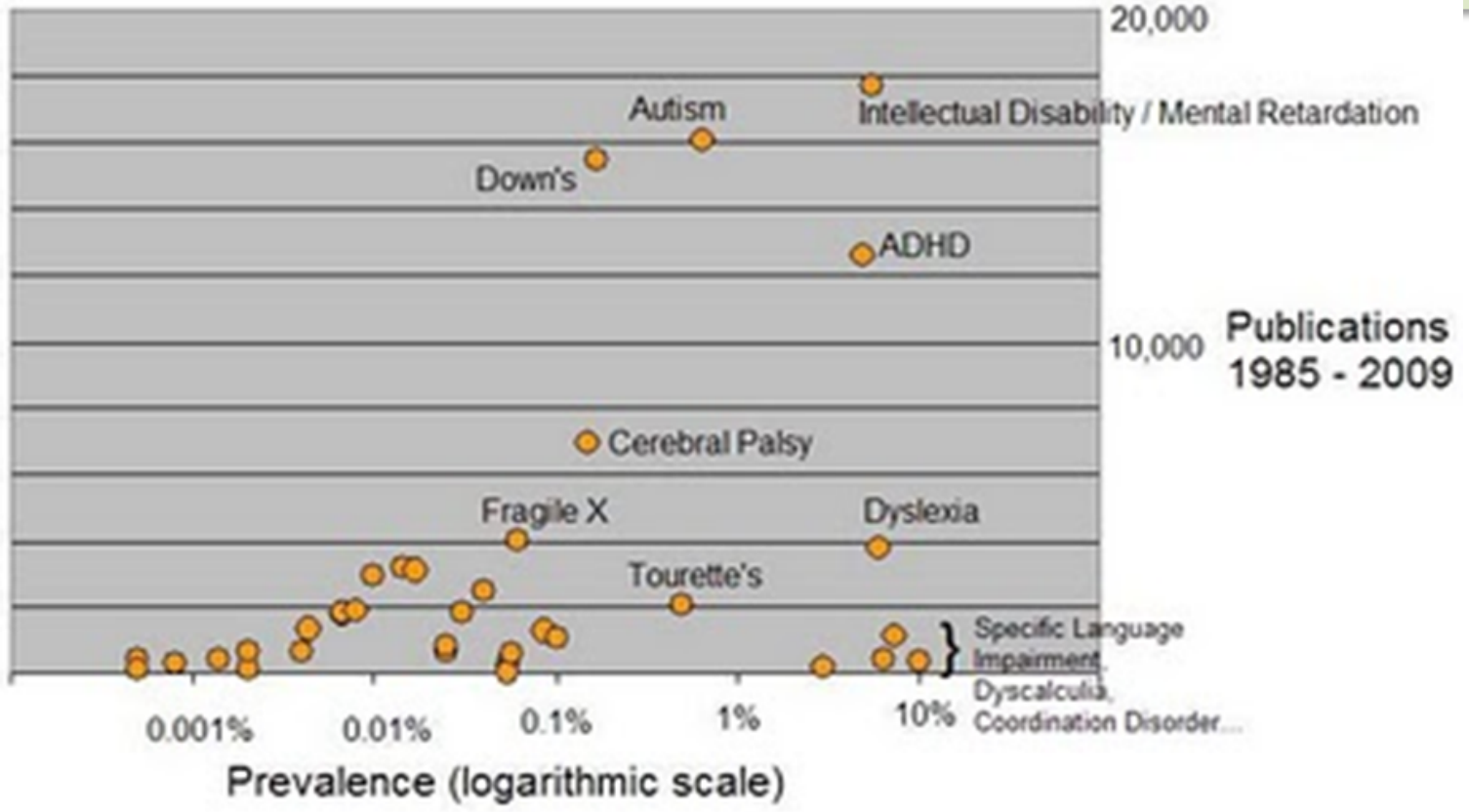
Other Disabilities Affecting Speech and Language

- Language and speech disorders: linguistic in nature -> directly related to language and speech

- Some disorders involve other difficulties or abnormalities while also affecting speech and language:

- Autism
- Intellectual Disability (Mental Retardation) (e.g. Down Syndrome).
- Cerebral Palsy
- Cleft Palate
- A stroke or head injury
- Dementia

Amount of research for disorders which affect language



Very common disorders like dyslexia, dyscalculia, and specific language impairment are understudied.

Common Features of Language Disorders

1. Inappropriate use of grammatical forms
2. Limited vocabulary development
3. Difficulty in spelling and writing
4. Difficulty in processing long sentences
5. Difficulty in processing compound and ambiguous words
6. Sound substitutions in words
7. Difficulty in processing sounds into syllables and words
8. Inability to follow directions, remember questions or numbers and letters in sequence
9. Improper use of words, confusion about their meaning
10. Difficulty in expressing ideas and thoughts

Aphasia

- Impairment of language ability
- Ranges from difficulty in remembering words to completely inability to speak, read, or write
- Aphasia disorders usually develop quickly as a result of head injury or stroke, but can develop slowly from a brain tumor, infection, or dementia

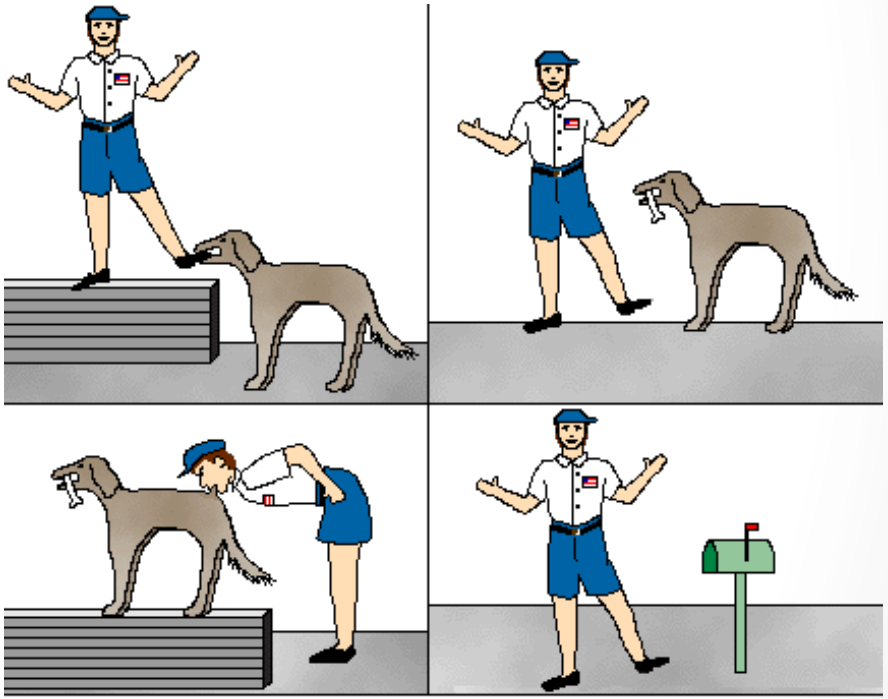
Inabilities of People with Aphasia

- difficulty in naming
- inability to comprehend language
- inability to pronounce
- inability to speak spontaneously
- inability to form words
- excessive creation and use of personal neologisms
- paraphasia (substituting letters, syllables or words)
- agrammatism (inability to speak in a grammatically correct fashion)
- incomplete sentences
- inability to read
- inability to write
- limited verbal output

Agrammatism in Aphasia

Inability to process grammar including errors in:

- Tense
- Number
- Gender
- Wh-questions
- Complex sentences
- Passive voice



The dog bit the postman.
The dog was bitten by the postman.

Dyslexia

Unexpected difficulty in reading in children and adults who otherwise possess adequate intelligence and motivation.

Typical difficulties:

- Inability to recognise symbols representing sounds or numbers
- Perceiving combination of letters in a reversed way
- Find it confusing when one shape in different positions can represent several different sounds ('p', 'q' ,'b' and 'd‘)
- Similarly-looking words like 'ambiguous' and 'ambitious' easily confused
- Dyslexics find spelling very difficult
- Dyslexic readers regularly skip words in a text, or may add words, duplicate them or reverse word order.

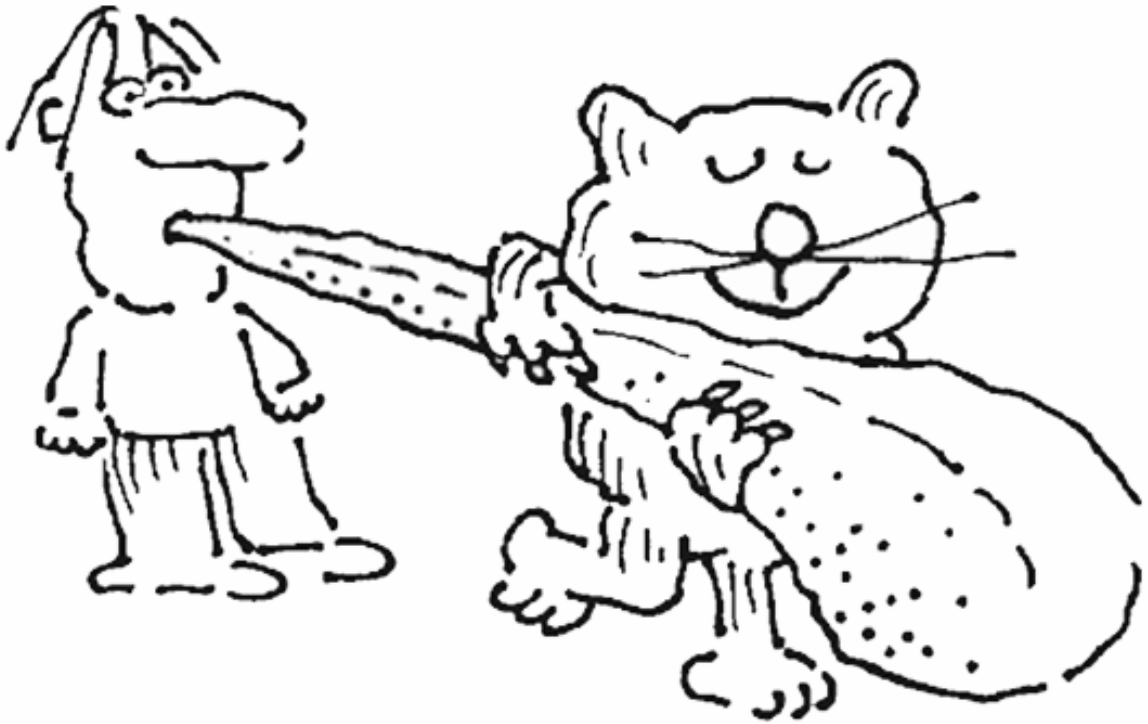
Autism Spectrum Disorders

- Complex neurobiological disorder of development lasting throughout person's life.
- Main signs and symptoms of autism involve language, social behaviour, and behaviours concerning objects and routines.

- Main language processing difficulties include:

- Cannot start or maintain a social conversation
- Does not refer to self correctly
- Poor understanding of :
  - figurative language
  - compound words (waterfall; sunshine; self-destructive);
  - abstract notions (love, sorrow, kindness, friendship);
  - pronouns and prepositions;
  - complex-compound sentences
  - sarcasm, irony, ambiguity;

Difficulties in understanding figurative language



Has the cat got your tongue?

Dementia (incl. Alzheimer's Disease)

Symptoms include difficulty with many areas of mental function, including: Language, Memory, Perception, Emotions and Cognitive skills. Alzheimer's is the most common cause of dementia.

Typical language difficulties include:

- Word pronouncing
- Replacement of certain words and producing nonsensical sentences
- Word repetition
- Inability to construct and pronounce a completed sentence
- Use of gestures instead of words
- Repetition of questions or certain phrases

Part II: NLP for language disabilities

- 1. Language disabilities
- 2. NLP for language disabilities
- 3. FIRST: overview
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Text simplification: why?

Reminder: common features of language disorders

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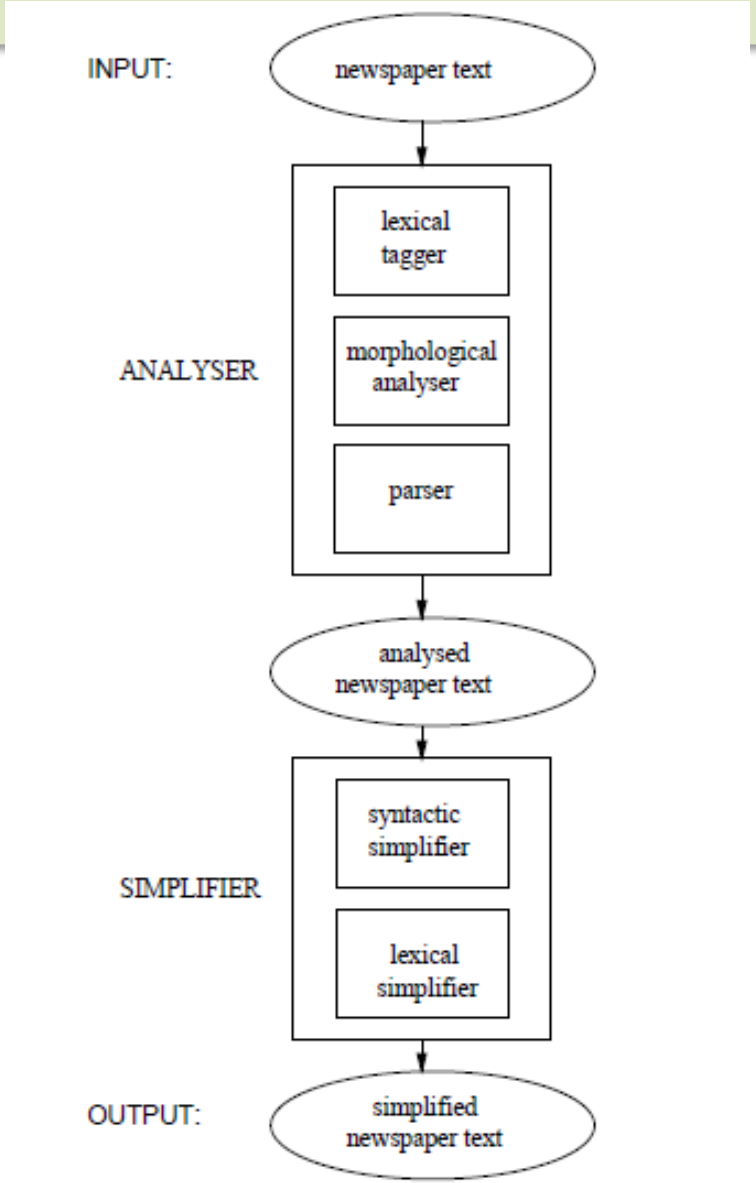
Text simplification projects for people with language disabilities

- English: ≥ 3 projects of automatic text simplification for people with aphasia and 1 for congenitally deaf people.
- Portuguese: *PorSimples* project for people with rudimentary literacy level, and people with cognitive disabilities.
- Spanish: *Simplext* project for people with cognitive disabilities.

Feasibility of automatic simplification of newspaper stories for aphasics (Devlin, 1999)

- Based on both lexical and syntactic simplification
- Practical implementation: only lexical simplification (difficult infrequent words replaced with their simpler synonyms)

PSET - Practical Simplification of English Texts (Carroll et al. 1998)



System architecture (Carroll et al., 1998)

- Rule-based syntactic simplification component
- Lexical simplification exploiting WordNet lexical database and Oxford Psycholinguistic Database.

HAPPI - Helping Aphasic People Process Information (Devlin and Unthank, 2006)

- Objective: help aphasic people to access web based information, e.g. online news stories
- Methodology:
- Substitution of difficult words by more common or easier synonyms
- Substitutes searched in databases with the psycholinguistic properties of words, e.g. how frequent and familiar they are

Text simplification for congenitally deaf people (Inui et al., 2003)

- Congenitally deaf people can have difficulties in reading and writing text.
- Objective: to provide a reading assistance system which lexically and structurally paraphrases a given text into a simpler and plainer one.
- 3 stages:
  - Problem identification
  - Paraphrase generation
  - Evaluation

Simplext

- First text simplification system for Spanish
- To make text accessible to people with cognitive impairment
- Simplification and lexical and syntactic level
- Simplext corpus: original texts and their simplified versions
- Empirical study of lexical simplification (Drndarević and Saggion 2012)
- Syntactic level: sentence splitting, lexical substitution of multi-word units and re-ordering (Bott Saggion and Mille 2012).

Luz Rello's research on dyslexia

Estimating Dyslexia in the Web
(Baeza-Yates and Rello 2011)

- Particular words in the web can be used to detect dyslexic texts, and hence dyslexic users
- At least 0.63% of the lexical errors in the Web are dyslexic errors in English, 0.43% in Spanish.

Types of simple errors:

- substitution: **reelly (really)*
- insertion: **situartion (situation)*
- omission: **approch*
- transposition: **artcile (article)*

Luz Rello's research on dyslexia (2)

Experiments related to readability and understanding (Rello et al. 2012a; Rello et al. 2012b)

- The layout (design) of the text matters in terms of readability
  - Use of graphical schemes may improve readability (but not understanding)
  - Lexical errors have negative influence on readability and understanding
- Developing NLP tool based on user needs

Guiding Word-Finding with Semantic Associations (Nikolova et al. 2010)

1) Objective: easier vocabulary navigation and word-finding via vocabulary network where links reflect human judgments of semantic relatedness.

2) The study compares:

LG Vocabulary	• organises words according to shared contexts that are common in daily life
ViVA (Visual Vocabulary for Aphasia)	• relies on word frequency usage, user preferences and semantic word associations

3) Participants found ViVA less confusing to navigate

STANDUP Pun Generator for Children with Cerebral Palsy (Waller et al. 2009)

1. Generates punning riddles for users with physical, speech, and language impairments:

- "What do you call a murderer with fiber? . . . A cereal killer."
- "What do you get when you cross a monkey and a peach? . . .An ape-ricot."

2. Features

- Extensive lexicon with information on phonetic similarity of words;
- Speech output;
- Picture-word matching using AAC graphic symbol sets
- Scoring system to rate familiarity of words (and restrict vocabulary words users more likely to know)
- Blacklist to prevent inappropriate words being used in jokes

Part III: FIRST overview

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FIRST FIRST FIRST FIRST FIRST FIRST FIRST FIRST

A Flexible Interactive Reading Support Tool (FIRST)

OVERVIEW

Aim

- Aims to deliver language technology to convert documents into a personalised form enabling easy comprehension
  - Reducing complexity
    - Words (morphological)
    - Sentences (syntactic)
  - Removing ambiguity
    - Word meanings
    - Pronouns
    - Figurative language
  - Improving readability
    - Adding pictures
    - Adding document navigation tools
    - Providing concise summaries of long documents
    - Replacing technical words with more common ones

Beneficiaries

- This technology will be beneficial for:
  - People with reading difficulties:
    - Autistic spectrum disorders
    - Developmental language disorders
    - The elderly
    - Migrants
    - Tourists
  - Intermediaries supporting these populations
- Technology will be formally tested for use by people with autistic spectrum disorders (ASD) and their intermediaries (carers and healthcare providers).

Beneficiaries

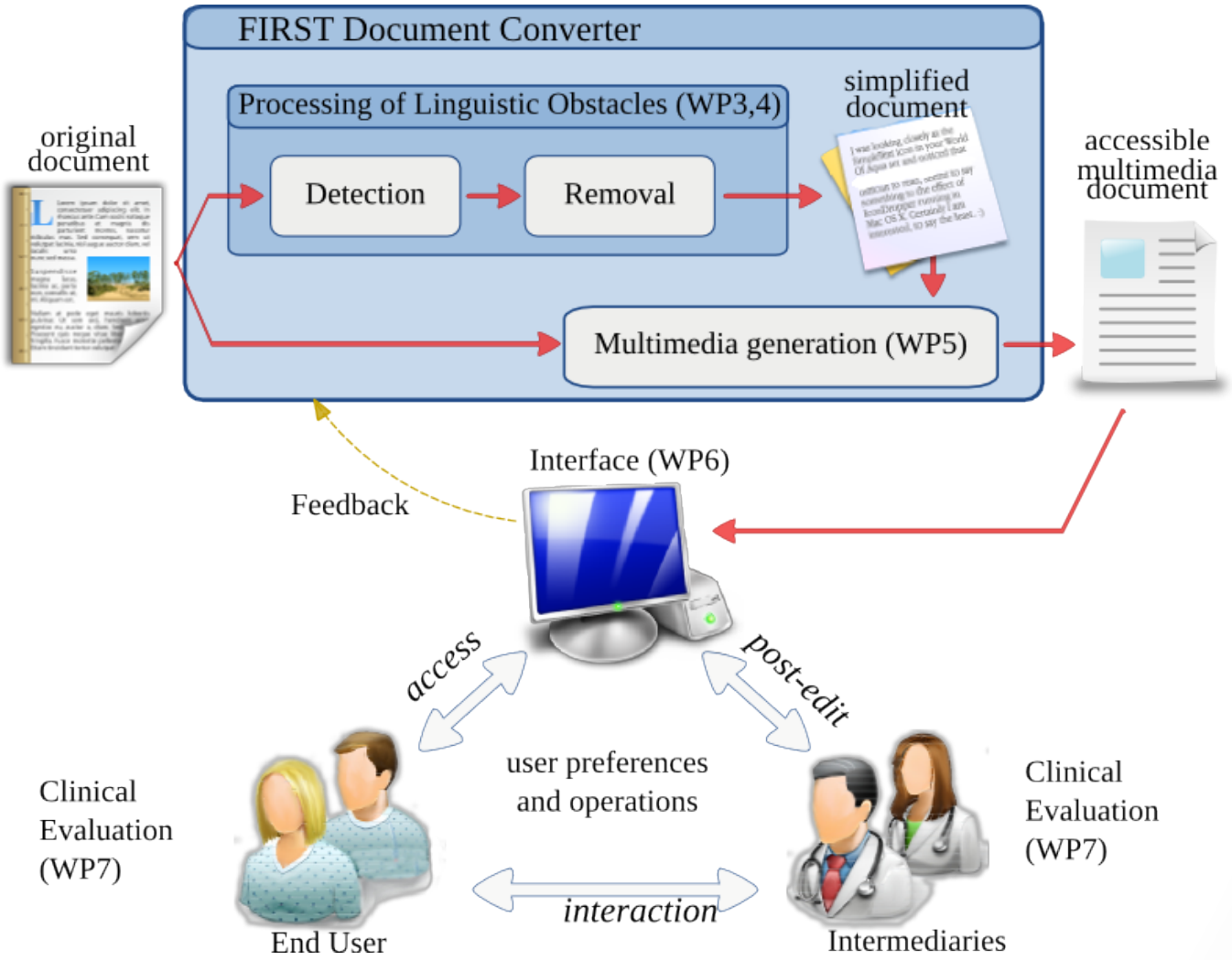
- Autistic spectrum disorders
  - Estimated to affect 60 people in every 10 000 in the EU (approximately 3 million people)
  - Reading difficulties caused by ASD pose a significant barrier to inclusion
    - Access to education, employment, culture, and communication (OECD report 2000; Brugha et al., 2007)

Our vision

- To develop a widely-used content proofing system enabling users to access electronic documents (e.g. web pages and e-books).
- FIRST will convert input documents into personalised form in accordance with user preferences

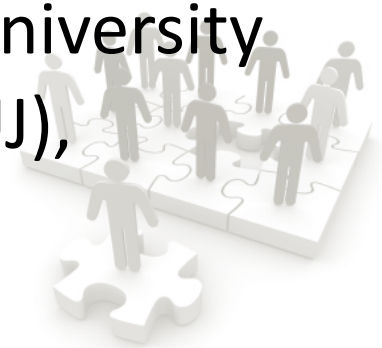
Our vision

- The FIRST tools will implement a conversion process including:
  - Replacement of
    - long complex sentences by sequences of short simple sentences
    - long words by short, simple words
    - non-literal language by literal translations
    - highly technical words by more common words
  - Definition of ambiguous words or phrases
  - Addition of
    - Images
    - Concise summaries
    - Document navigation tools for long documents


FIRST Document Converter
Processing of Linguistic Obstacles (WP3,4)
Detection
Removal
simplified document
original document
accessible multimedia document
Multimedia generation (WP5)
Interface (WP6)
Feedback
access
post-edit
user preferences and operations
interaction
Clinical Evaluation (WP7)
Clinical Evaluation (WP7)
End User
Intermediaries

The consortium

- Partners involved in
  - Healthcare: Delatrea (DEL), Central and North West London NHS Foundation Trust (LNFT), Parallel World (PW)
  - Advocating the rights of people with Autism: Autisme Europe (AE)
  - Software solutions: IWEB, Kodar (KDR)
  - Research in language technologies: University of Alicante (UA), University of Jaen (UJ), University of Wolverhampton (UW)



Implementation: Realising our vision

Realised by meeting project objectives:

- **Obj-1** User Requirements (WP2)
- **Obj-2** Developing LT to Convert Documents into a Personalised Form (WP3-7)
  - **Obj-2.1** Processing Structural Complexity (WP3)
  - **Obj-2.2** Processing Ambiguity in Meaning (WP4)
  - **Obj-2.3** Generation of Personalised Documents (WP5)
  - **Obj-2.4** Software Integration (WP6 and WP7)
- **Obj-3** Deployment and Evaluation of FIRST (WP7)
  - **Obj-3.1** Quantitative Evaluation
  - **Obj-3.2** Qualitative Evaluation

And also by

Ensuring take up of FIRST by lead users

- Dissemination (WP8)
- Exploitation (WP9)

Obj-1 User Requirements

- Achieved by:
  - Activity in *WP2 User Requirements*
    - Exploiting the expertise of clinical partners [DEL, LNFT] and partners providing support for people with ASD [AE, PW]
  - Clustering activities with related projects (ASC-Inclusion)
- Addressing needs & Issues:
  - Need for technology relevant and useful for end users
  - Current descriptions of reading comprehension difficulties too general to be exploited in the development of concrete LT
- Expected impacts
  - Better understanding of needs of users with ASD when seeking to access electronic documents

Obj-2 Developing LT to Convert Documents into a Personalised Form

- Achieved by
  - Meeting sub-objectives to develop LT components (**Obj-2.1** – **Obj-2.4**)
  - WP7 *Evaluation and Testing* of LT components
  - Exploiting
    - expertise of LT [UA, UJ, UW], software engineering [IWEB, KDR], and healthcare [DEL, LNFT] partners
    - a strong LT baseline
- Addressing needs & issues:
  - People with ASD are at risk of exclusion due to their difficulties in reading comprehension
- Expected impacts
  - Better access to written information, improved quality of life
  - Improvements in the state of the art of the relevant fields of LT

Obj-2.1 Processing Structural Complexity

- Achieved by
  - WP3 *Processing Structural Complexity*
  - Exploiting
    - expertise of LT [UA, UJ, UW] and software engineering [KDR] partners
    - A strong LT baseline
    - Activities in *WP2 User Requirements* and *WP7 Testing and Evaluation*
- Addressing needs & issues:
  - People with ASD have difficulties reading long and complex words and sentences
  - Existing LT requires further development and customisation in order to process structural complexity relevant to people with ASD

Obj-2.2 Processing Ambiguity in Meaning

- Achieved by
  - WP4 *Processing Ambiguity in Meaning*
  - Exploiting
    - expertise of LT [UA, UJ, UW] and software engineering [KDR] partners
    - A strong LT baseline
    - Activities in *WP2 User Requirements* and *WP7 Testing and Evaluation*
- Addressing needs & issues:
  - People with ASD have difficulties understanding figurative/non-literal language and semantically ambiguous or highly technical words/phrases
  - Existing LT requires further development and customisation in order to process the types of ambiguity in meaning relevant to people with ASD

Obj-2.3 Generation of Personalised Documents

- Achieved by
  - WP5 *Generation of Personalised Documents*
  - Exploiting
    - Expertise of LT [UA, UJ, UW] and software engineering [KDR] partners
    - A strong LT baseline
    - Activities in *WP2 User Requirements* and *WP7 Testing and Evaluation*
- Addressing needs & issues:
  - Addition of personalised content (images, summaries, document navigation aids, pre-reading questions) to written documents shown to improve reading comprehension of people with ASD.

Obj-2.4 Software Integration

- Achieved by
  - WP6 *System Architecture and Software Integration*
  - Exploiting
    - Expertise of software engineering [IWEB, KDR] and LT [UA, UJ, UW] partners
    - Activities in *WP2 User Requirements* and *WP7 Testing and Evaluation*

Obj-3 Deployment and evaluation of FIRST

- Achieved by
  - Meeting sub-objectives **(Obj-3.1 – Obj-3.2)**
  - Exploiting
    - Expertise of healthcare [DEL, LNFT] and LT [UA, UJ, UW] partners
    - A strong LT baseline
- Addressing needs & issues:
  - People with ASD at risk of exclusion due to reading comprehension difficulties. Studies of benefit that LT can make in helping to prevent the exclusion of people with ASD scarce/non-existent
- Expected impacts
  - Improved understanding of
    - the contribution that LT can make to the quality of life of people with ASD and their perceptions of inclusion

Obj-3.1 Quantitative Evaluation from the User Perspective

- Achieved by
  - WP7 *Testing and Evaluation*
    - Usability surveys of users and intermediaries
    - Reading comprehension testing of end users
    - Evaluation of LT components
  - Exploiting
    - Expertise of healthcare [DEL, LNFT], LT [UA, UJ, UW], and software engineering [IWEB, KDR] partners
- Addressing needs & issues:
  - No studies so far on the impact of LT to convert documents into personalised form facilitating reading comprehension for people with ASD.
  - In the state of the art, evaluations are based on extrinsic evaluation via dependent LT components rather than being user focused or based on reading comprehension testing

Obj-3.2 Qualitative Evaluation: Study into Inclusion and Stigmatisation

- Achieved by
  - WP7 *Testing and Evaluation*
    - Initial key informant interviews with users and intermediaries (carers)
    - In-depth interviews with users
    - Focus group consultation
  - Exploiting
    - Expertise of healthcare [DEL, LNFT] and supporting patients with ASD [PW]
    - Expertise in evaluation methodology
    - Existing relationships with users and intermediaries
- Addressing needs & issues:
  - Social exclusion due to reading difficulties problem for autistic people in mainstream education. Studies of this phenomenon are scarce

Ensuring take up of FIRST by lead users

- To be achieved by two WPs
  - WP8 Dissemination
  - WP9 Exploitation
- Exploiting experience and networks built up by industrial partners and organisations supporting people with ASD [AE, DEL, IWEB, KDR, LNFT, PW]

Challenges

- Interaction between different components
  - Complexity can be measured along many different dimensions
    - Manage cases where removal of one type of obstacle introduces another type of obstacle (e.g. highly technical vs. highly ambiguous)
    - Need to ensure that *WP2 User Requirements* leads to an optimal solution from the user perspective

Challenges (2)

- Personalisation
  - Language is complex
    - Unrealistic to directly ask end users for a technical specification of their preferences
    - Technical specification must be obtained indirectly by careful design of easy-to-answer survey items e.g.
      - By presenting users with sets of sentences of varying complexity and asking them to indicate those that are inaccessible without simplification
      - By exploring other forms of rapid-answer comprehension testing

LANGUAGE IS IRREGULAR

AND AMBIGUOUS

Part 4. FIRST: What have we done so far

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Results so far

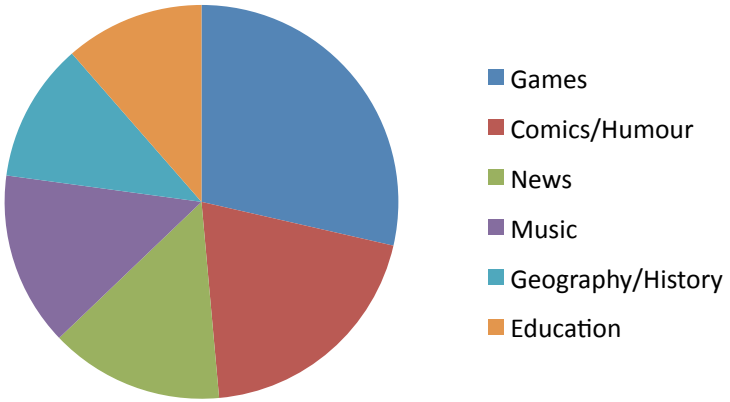
1. Exploring requirements of users with ASD
   a. Systematic review
   b. Questionnaire surveys
2. Development of evaluation resources to support LT development
   a. Syntactic complexity
   b. Coreference
   c. Figurative language
3. Language Technology (LT) Development

1. Exploring requirements of users with ASD

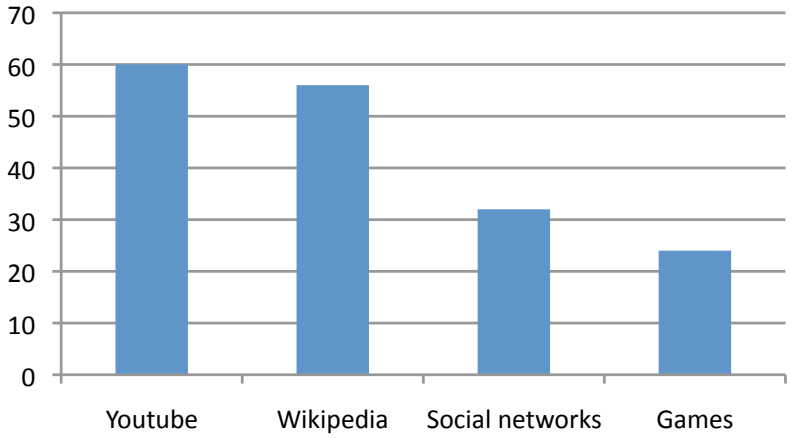
a. Systematic review
b. Questionnaires/Surveys (people with Asperger's syndrome, ages 12-39)
    i. Generic information about web usage
    ii. Language specific issues

1.b.i. Web usage

- Primary topics of interest:

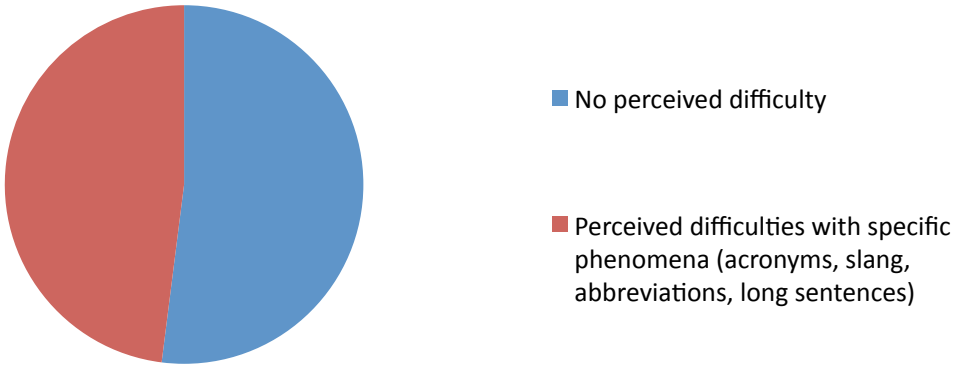


- Websites frequented (%):

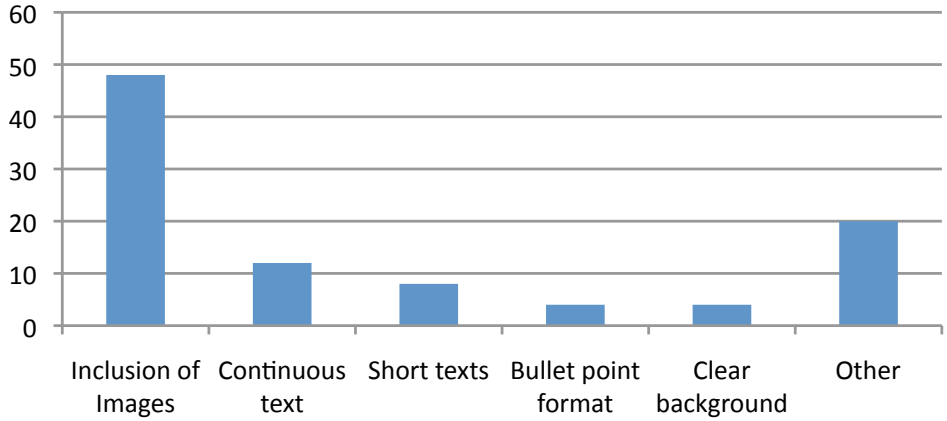


1.b.i Web usage

- Perceptions of comprehension problems:

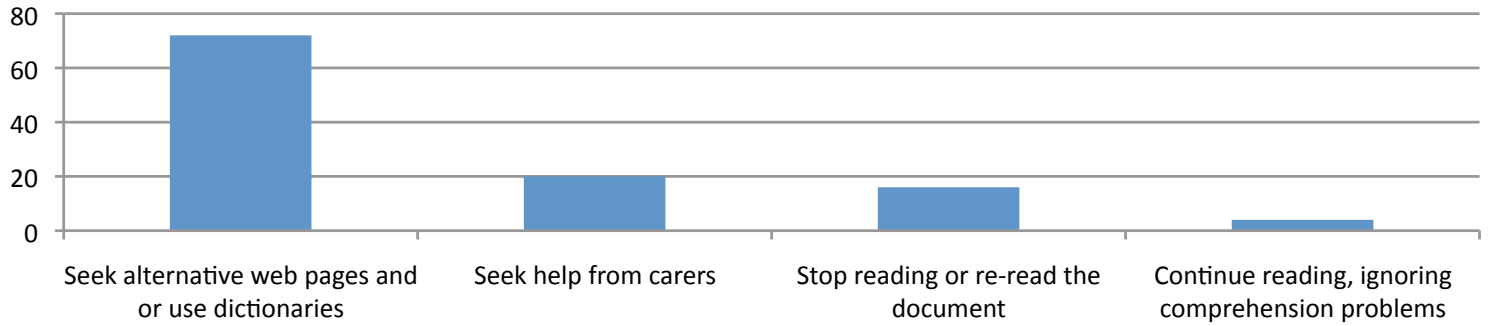


- Preferred document formats (%)

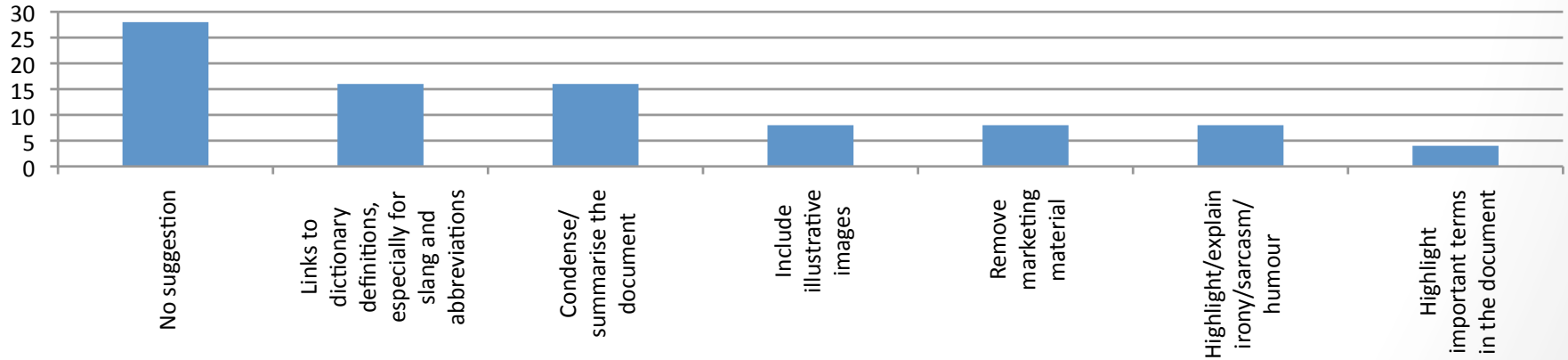


1.b.i Web usage

- Reactions to perceived comprehension problems (%):



- Solutions proposed by readers with ASD (%):



2. Resources to support LT development

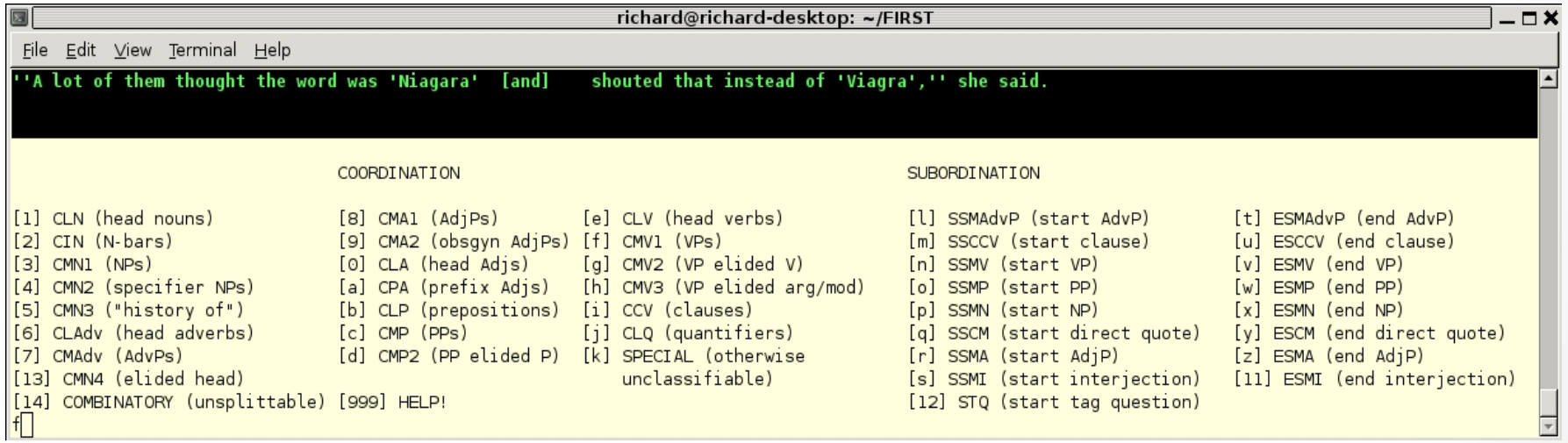
- Corpora (news, healthcare information for patients, fiction):
  - Annotation:
    a. Linking function of conjunctions, punctuation, and complementisers
    b. Coreference
    c. Figurative language
    d. Image corpus

2.a. Annotation of coordination and subordination

- Information about syntactic complexity is annotated in a corpus. There are three types of element:
  - Coordinators (punctuation/conjunctions)
    - annotated with information about the conjoins that they link together (e.g. Clauses, NPs, VPs, etc.)
  - Leftmost boundaries of subordinated constituents (punctuation/complementisers)
    - Annotated with information about the subordinated constituent
  - Rightmost boundaries of subordinated constituent (punctuation)
    - Annotated with information about the subordinated constituent

2.a. Annotation of coordination and subordination

- A simple annotation program has been developed for this purpose



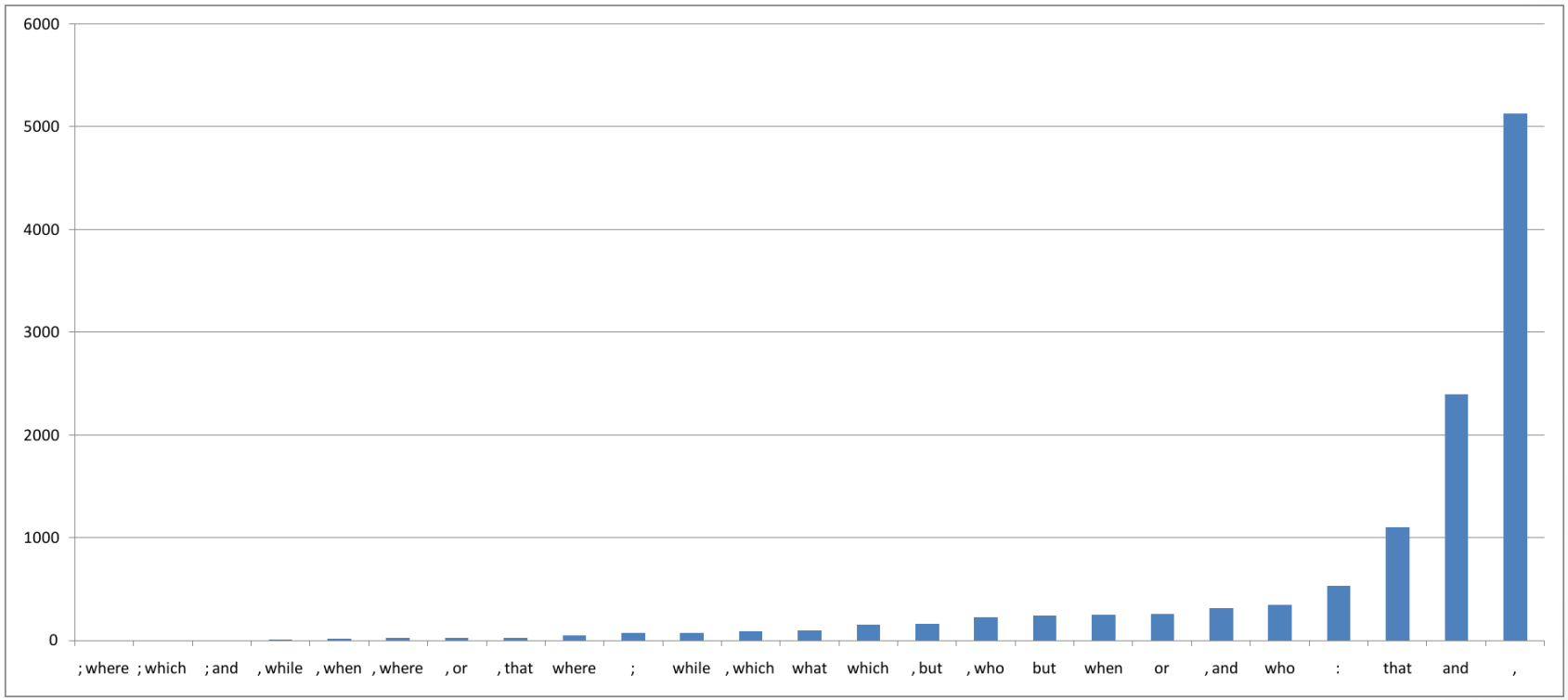
2.a. Annotation of coordination and subordination

- The annotation will create a data file with a format such as

```
<DOCUMENT ID="METER-2">
<P ID="1">
<S ID="1">A COMPOSER of classical music was
    ''dismayed'' <PC ID="1" TYPE="CMV1">and</PC>
    could not believe what he had read when an
    article in The Times accused him of organising
    hecklers ''to go about wrecking performances of
    modern atonal music''<PC ID="2"
    TYPE="SSCCV">,</PC> the High Court was told.</
    S>
</P> ...
```

2.a. Annotation of coordination and subordination

- So far 11 608 instances have been annotated



2.a. Annotation of coordination and subordination

- So far 11 608 instances have been annotated
- Kappa is 0.8002 (for a sample of 1564 cross-annotated instances)
- The corpus is currently on its third revision and we expect to make it publicly available before September 2012.

3. LT Development

a. Syntactic simplification
b. Coreference resolution
c. Personalised Document generation
    i. Image retrieval

3.a. Syntactic simplification

So far, our work in FIRST has focused on development of the syntactic simplification module.

This module is used to:

i. Detect syntactic obstacles to reading comprehension

ii. Remove syntactic obstacles to reading comprehension

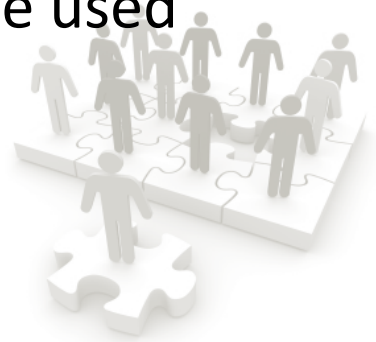
3.a.i Detecting syntactic obstacles

We have explored different methods to quantify the syntactic complexity of sentences in texts from various genres

Sanja Stajner will present this in more detail later in this Workshop.

3.a.ii Removing syntactic obstacles

- At WLV, we developed a system to simplify sentences in a restricted genre/domain (clinical vignettes)
- In FIRST, this system (Evans, 2011) is being adapted for texts that:
  - are less tightly edited
  - belong to different genres
  - contain more variety in terms of language used
    - a wider variety of types of subordination



3.a.ii Removing syntactic obstacles

- The rewriting process is based on:
  - Detecting **potential coordinators**
    - punctuation marks, conjunctions, complementisers, and wh-words
  - Classifying the linking function of potential coordinators

3.a. Classifying potential coordinators

- What kind of information is suitable for predicting the class of potential coordinators?
  - In related work, contextual information was found to be useful (Evans, 2011):
    - Detection of particular words and parts of speech that both precede and follow a potential coordinator in the same sentence
    - Signals of phrase boundaries of different grammatical types
    - Neighbouring words and part of speech tags
- The automatic classifier is under development

3.b. Sentence rewriting

- Once potential coordinators have been classified, complex sentences can be rewritten as sequences of simple sentences
- Sentence rewriting also relies on:
  - Part of speech tagging
  - A recursive algorithm to simplify the sentence
    - The algorithm uses a function that takes one complex sentence as input and converts it into two simpler sentences in each iteration
- The rewriting method has been developed and used in conjunction with the manually annotated corpus

3.b. Sentence rewriting (algorithm)

Input: Sentence containing coordinated constituents, s_0
Output: Array of simple sentences, A

1 $A \leftarrow \emptyset$;
2 $S \leftarrow \{s_0\}$;
3 **while** $S \neq \emptyset$ **do**
4 $\quad s_i \leftarrow pop(S)$;
5 $\quad$ **if** s_i *contains a potential coordinator of a type/class that can be detected reliably and is associated with a simplification rule* **then**
6 $\quad\quad \{s_{i_1}, s_{i_2}\} \leftarrow simplify(s_i)$;
7 $\quad\quad S \leftarrow S \cup \{s_{i_1}, s_{i_2}\}$;
8 $\quad$ **else**
9 $\quad\quad A \leftarrow A \cup \{s_i\}$
10 $\quad$ **end**
11 **end**

3.b Sentence rewriting (rules)

- The rules exploit information about
  - the type of potential coordinator,
  - the class of potential coordinator,
  - the preceding and following text:
    - parts of speech related to the class of potential coordinator (especially prepositions and verbs),
    - parts of speech indicating the syntactic role of the coordinated constituent,
    - sentence boundaries

4. Next steps

- Develop rules to rewrite sentences containing subordination according to user preferences
  - Delete
  - Rewrite as two sentences:
    1. The original with the subordinate clause deleted
    2. The subordinate clause with the complementiser/wh-phrase replaced by the part of the bigger phrase that precedes it. E.g.
       - *John,* [[*who*] *had been to the US*], *returned to Europe.*
       - *John had been to the US. John returned to Europe.*
- Conversion of complex sentences into bullet-point formats

Part 5. FIRST: upcoming work

1. Language disabilities
2. NLP for language disabilities
3. FIRST: overview
4. FIRST: what we have done so far
5. FIRST: upcoming work
6. Related on-going and forthcoming research

Upcoming work

September 2012

- Deployment of user surveys to quantify
  - Reading difficulties
  - User requirements (end users and intermediaries)
- Delivery of early-stage prototype of the ***Open Book*** software ("*OB-1*") to test software architecture.
  - It will include only subset of functions

March 2013

- Delivery of first fully functional prototype

Upcoming work

September 2013

- Deployment of second prototype to users (people with ASD and carers) for six month trial

March 2014

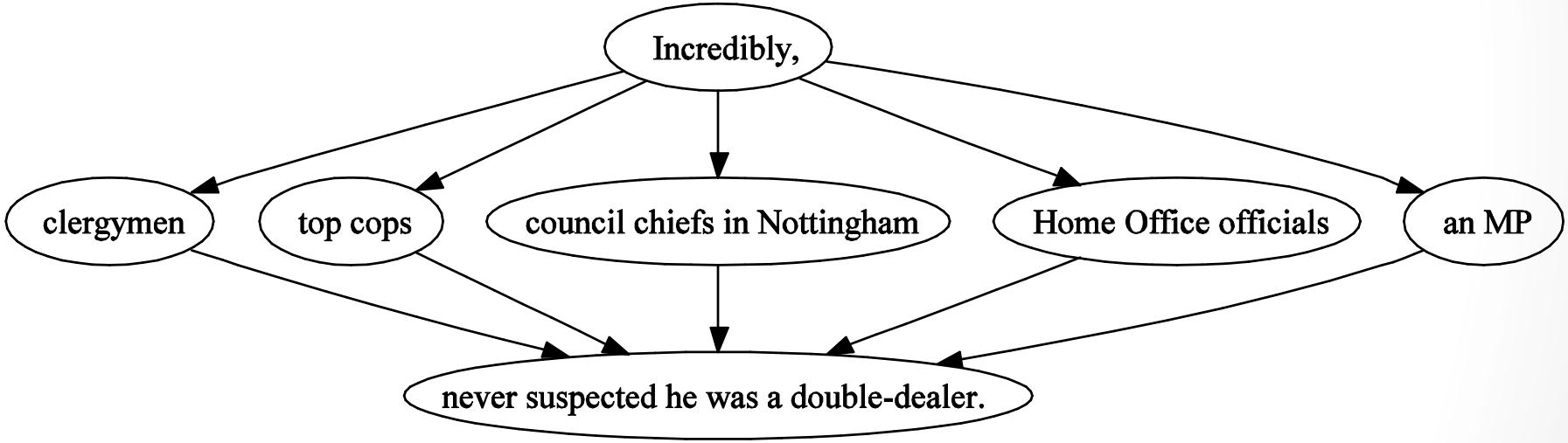
- Delivery of final prototype which addresses any issues raised during the user trial

Experimental results: syntactic simplification

- Consider sentence (1):
  - (1) *Incredibly, council chiefs in Nottingham, Home Office officials, top cops, clergymen and an MP never suspected he was a double-dealer.*
- Currently, our approach to syntactic simplification produces:
  - *Incredibly, clergymen never suspected he was a double-dealer.*
  - *Incredibly, top cops never suspected he was a double-dealer.*
  - *Incredibly, council chiefs in Nottingham never suspected he was a double-dealer.*
  - *Incredibly, Home Office officials never suspected he was a double-dealer.*
  - *Incredibly, an MP never suspected he was a double-dealer.*

Experimental results: syntactic simplification

- This output includes a lot of redundancy.
  - We developed a module to build a graph representation automatically
  - Allows the same information to be presented more concisely



  - We do not yet know whether users find this type of representation more comprehensible


287607 FIRST
It's raining cats and dogs…

Part 6. Related on-going and forthcoming research

1. Language disabilities
2. NLP for language disabilities
3. FIRST: overview
4. FIRST: what we have done so far
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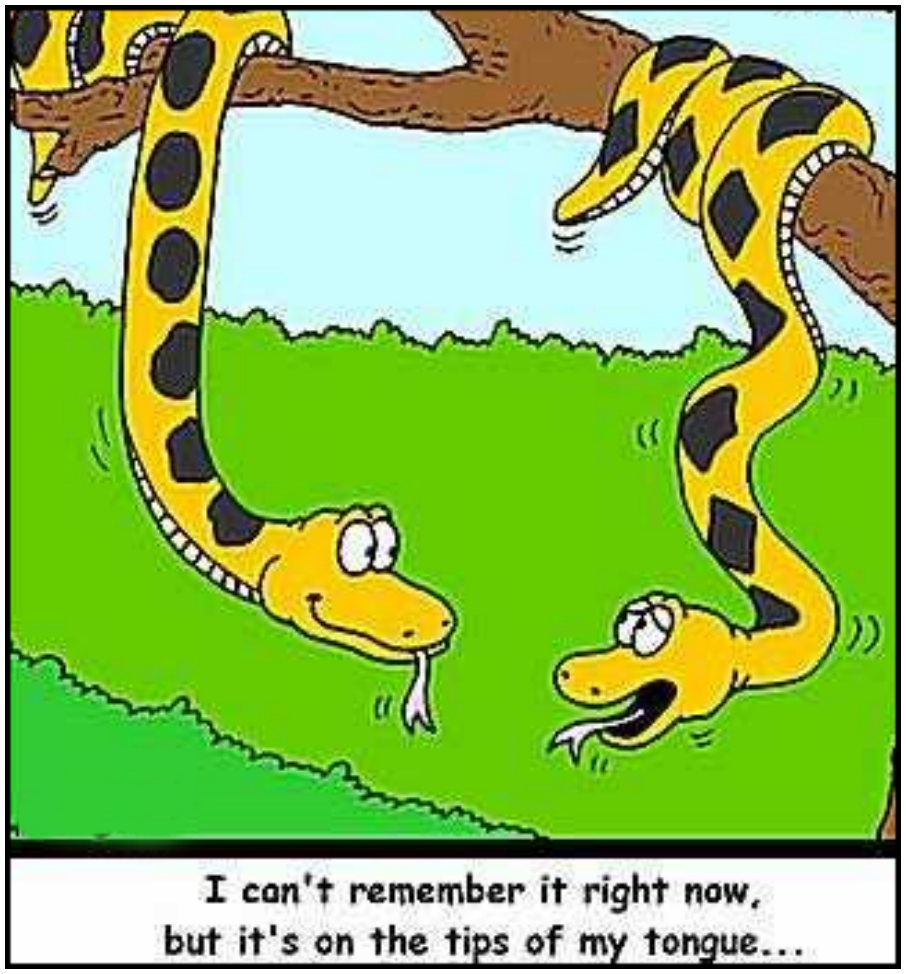
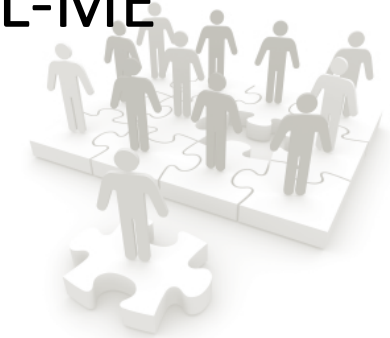
6. Related on-going and forthcoming research

Alzheimer's Disease



On-going and forthcoming related work

- Test validity of finding
- Bilingualism/ foreign language learning contribute to delay in symptom onset / cognitive reserve (Schweizer et al. 2011)
- Develop a foreign language learning environment geared towards and adapted to people with AD
- Build on current Leonardo project TELL-ME



Acknowledgments





Natural Language Processing and Language Disabilities

Ruslan Mitkov