Jaargang 21, Supplement 1, september 2016

# Stem-, Spraak- en Taalpathologie

## *17th International*

## *Science of Aphasia Conference*

# Conference Program

## Sunday, September 25, 2016

**Arrival**

## Monday, September 26, 2016

**8.30 – 9:30 Registration**

**Session One: 9.30 – 13.00 (Coffee break around 11.00)**

Introduction David Howard

Gary Dell

Greg Zubicaray

Discussant David Howard

**13:00 – 15:00 Lunch**

**15:00 – 17:00 Contributed Papers I (Grammar and syntax)**

1. Vitor C. Zimmerer, Loveday Newman, Rosalind Thomson, Rosemary A Varley -Frequency and strength of word collocations distinguish speakers with fluent aphasia, non-fluent aphasia, right hemisphere damage and non-brain-damaged controls

2. Valantis Fyndanis, Dimitra Arfani, Francesca Burgio, Anna Maculan, Fabio Palla, Spyridoula Varlokosta, Sokratis Papageorgiou, Annachiara Cagnin, Carlo Semenza - Morphosyntactic production in Greek and Italian probable Alzheimer's disease: Evidence from agreement, tense, and mood

3. Heilemann, C., Varley, R., Zimmerer, V., Carragher, M., & Beeke, S.- Grammatical structures in agrammatism: a usage-based investigation of multi- word expressions

4. Dimitra Mamouli, Stavroula Stavrakaki, Panagiotis Ioannidis - Lexical, morphological, and syntactic abilities in patients with Semantic Dementia

5. Christina Manouilidou, Michaela Nerantzini, Brianne Dougherty, Cynthia K. Thompson - Processing Complex pseudo-words in Primary Progressive Aphasia and Agrammatic Aphasia

6. Io Salmons & Anna Gavarró - The role of morphology and prosody in agrammatic comprehension

**17:00 – 17:30 Short presentations Poster Session I**

1. Yulia Akinina, Olga Dragoy, Nina Dronkers - Functional Neuroanatomy of Semantic Aphasia

2. Reem S. W. Alyahya, Ajay Halai, Paul Conroy, Matthew A. Lambon Ralph - Verb comprehensionin post-stroke aphasia: A novel verb semantic battery

3. Miren Arantzeta, Janet Webster, Itziar Laka, Maite Martinez-Zabaleta & David Howard - Cross-linguistic asymmetries in sentence comprehension deficits in bilingual Basque-Spanish aphasia. Evidence from eye-tracking and behavioural data.

4. Giorgio Arcara, Valentina Bambini, Elisabetta Mondin, Giulia Muriago, Edda Sgarabottolo, Gianettore Bertagnoni, Carlo Semenza - Communicative deficits in Traumatic Brain Injury: the relationship between executive and pragmatic impairment

5. C. Bonnans, R. Fargier, M. Laganaro - Impact of concurrent auditory tasks on picture naming in aphasia

6. De Letter, M., Bruggeman, A., De Keyser, K., Aerts, A., Van Mierlo, P., Strobbe, G, Boon, P., Van Roost, D, & Santens, P - Subcortical involvement in body and mental action verb processing: An electrophysiological registration study

7. Jakolien den Hollander, Roelien Bastiaanse, Marina Laganaro, & Roel Jonkers - Tracking speech production processes by using EEG and EMG

8. Charlotte Jacquemot, Christophe Lalanne, Agnès Sliwinski, Emmanuel Dupoux, Anne-Catherine Bachoud-Lévi - A new tool for aphasia evaluation: The Core Assessment of Language Processing (CALAP)

9. Bernard A. Jap & Roelien Bastiaanse - Sentence Production in Standard Indonesian Broca's Aphasia

10. Stefanie Keulen, Tine D'aes, Louis de Page, Jo Verhoeven, Roelien Bastiaanse, Peter Mariën - From foreign accent to neologistic jargon in a patient with psychogenic FAS

11. Orsolya Kis, Alinka Tóth, Lívia Ivaskó, Gabriella Gárdián, Katalin Jakab, László Vécsei - Numerical abilities of Hungarian aphasic patients

**17.30 – 18.30 Poster Session I**

## Tuesday, September 27, 2016

**Session Two: 9.30 -13.00 (Coffe break around 11.00)**

Introduction Carlo Semenza

Marina Laganaro

Davide Crepaldi

Discussant Gabriele Miceli

**13:00 – 15:00 Lunch**

**15:00 – 17:00 Contributed papers II (lexical problems)**

7. Elizabeth Anderson, Ruth Herbert and Patricia Cowell - Frequency affects processing of verbs and argument structure in acquired aphasia: results from a pilot investigation.

8. Nora Fieder, Trudy Krajenbrink, David Foxe, John Hodges, Olivier Piguet, Lyndsey Nickels - Less is more-Effects of semantic neighbourhood on naming in semantic dementia (svPPA)

9. Fedor Jalvingh, Roelien Bastiaanse, & Roel Jonkers -Verbal and nonverbal processing of objects and actions in three types of dementia

10. Julie Morris, David Howard, Janet Webster, Maria Garraffa – Reading Comprehension at the text level: Effect of text variables and question type

11. Trudy Krajenbrink, Karen Croot, Cathleen Taylor, & Lyndsey Nickels -
Exploring spoken and written word retrieval treatment in primary progressive aphasia

12. Cecilia Devers, David Howard, Janet Webster - Pronoun Processing in Aphasia

**17:00 – 17:30 Short presentations Poster session II**

12. Konstantina Kordouli, Christina Manouilidou, Stavroula Stavrakaki, Katerina Afantenou - Compound naming in agrammatism: evidence from stroke-induced and primary progressive aphasia

13. Lina Kort - Improving Naming in Aphasics: A Comparison of Three Intervention methods

14. Vasiliki Koukoulioti, Markus Bader- Thematic and word order canonicity in language: the effect of neurological impairment and age

15. Kuptsova S.V., Ivanova M.V., Akinina Y.S., Iskra E.V., Kozintseva E.G., Soloukhina O.A., Petrushevsky, A.G., Fedina, O.N. - Reorganization of cerebral functional activity in persons with aphasia following language therapy.

16. Kuzmina, E.E., & Weekes, B.S. – Inhibition and language processing deficits in different types of aphasia

17. Bruggeman, A., De Keyser, K., Aerts, A., Van Mierlo, P., Strobbe, G., Boon, P., Van Roost, D., Santens, P. & De Letter, M. - Subcortical involvement in phonological input processing: an electrophysiological registration study

18. Sabrina Mahmood Vitor C. Zimmerer, Rosemary A. Varley - Grammaticality Judgements in Aphasia and Parkinson's disease

19. Maxim, J., Best, W., Beckley, F., Edwards, S., Heilemann, C., Howard, D., Johnson, F., & Beeke Better Conversationsfor people with agrammatic aphasia and their conversation partners? Quantitative outcomes from intervention.

20. Minkina, I. & Martin, N.- Links between Verbal Short-Term Memory and Receptive Language Impairment in Aphasia

21. Mok Xue Ting, Joelle, Rosemary Varley, Vitor Zimmerer, Goh Siew Li, Leo Wei Zhi - Formulaic Language and Implicit Statistical Learning: A Comparison between Typical Development and Children with Acquired Language Disorders

22. Michaela Nerantzini, Sophia Apostolopoulou, Spyridoula Varlokosta and Roelien Bastiaanse - Time reference and Tense marking in Greek agrammatism. Evidence from narratives and a sentence completion task.

23. Ann-Katrin Ohlerth, Roelien Bastiaanse, Jaap van der Spek, Sebastian Cartens - Language mapping using object and action naming under Navigated Transcranial Magnetic Stimulation in a bilingual and two monolingual speakers.

24. Roelant Ossewaarde, Fedor Jalvingh, Roel Jonkers, and Roelien Bastiaanse - Computerized assessment of the acoustics of progressive aphasia.

**17:30 – 18:30 Poster session II**

**18:30 Meeting Scientific Committee**

## Wednesday, September 28, 2016

**9.30– 10.50 Contributed papers III**

13. Hameister, I. & Nickels, L.- The Cat in the Tree: What Picture Descriptions Tell us about Event-processing Deficits in Stroke- Induced Aphasia

14. Fleur van Ierschot, Antonio Miozzo, Barbara Santini, Giannantonio Spena, Andrea Talacchi, Gabriele Miceli - Language preservation in brain tumor patients undergoing awake surgery: Does monitoring object naming suffice to spare other language skills?

15. Nienke Wolthuis, Roelien Bastiaanse, Ingeborg Bosma, Perumpillichira J. Cherian, & Djaina Satoer - Abnormal slow-wave EEG activity in glioma patients is related to impaired language performance

16. Cornelia van Scherpenberg , Nora Fieder , Lyndsey Nickels, Sharon Savage - Performance consistency as an indication of storage deficit in people with semantic variant Primary Progressive Aphasia

**10.50 – 11.20 Short presentations Poster session III**

25. Michaela Nerantzini, Pola Drakopoulou, Spyridoula Varlokosta and Cynthia Thompson - The Northwestern Assessment of Verbs and Sentences (NAVS) and the Northwestern Anagram Task (NAT) as tools to assess grammatical deficits in Greek aphasia.

26. P. Pellet Cheneval, M. Villain, B. Glize, M. Laganaro - Is facilitation by phonological cues modulated by the size of the activated lexical cohort?

27. Python, Grégoire,Glize, Bertrand, Jeulin, Mélissa, Laganaro, Marina - Semantic facilitation vs interference in picture naming in a group of fluent aphasic speakers

28. Adrià Rofes, Lilla Zakariás, Klaudia Ceder, Marianne Lind, Monica Bloom Johansson,Jovana Bjekić, Valantis Fyndanis, Anna Gavarró, Hanne Gram Simonsen, Carlos Hernández Sacristán, Jelena Kuvač Kraljević, Silvia Martínez-Ferreir, Ilknur Mavis, Carolina Méndez Orellana, Lotte Meteyard, Io Salmons, Ingrid Sör, Ágnes Lukács, Müge Tunçer, Jasmina Vuksanovic, Spyridoula Varlokosta, David Howard - Word imageability from a cross-linguistic perspective

29. Soloukhina Olga, Isaev Dmitry, Akinina Yulia, Ivanova Maria - Differences in verb and noun comprehension in aphasia

30. Gloria Streit Olness - Foundations of narrative coherence in aphasia – examining the role of time reference and evaluative irrealis

31. Nina Unger, Nina Scholtes, Sandra Zitzen, Ferdinand Binkofski - Model-Oriented Therapy of Graphematic Paraphasias and Neologisms

32. Van Dun Kim, Wilssens Ineke, Mariën Peter - Electrical stimulation of the brain (tDCS) as a therapeutic tool in the treatment of Aphasia

33. Mile Vuković, Dušanka Matić, Ana Kovač, Irena Vuković, Chris Code - The public awareness of aphasia in Serbia and Montenegro

34. Vitor C. Zimmerer, Wolfram Hinzen, Felicity M. Deamer, Rosemary A. Varley - She knows X, she thinks X: Aphasic comprehension of factive and non-factive clausal embedding

35. Jürgen Steiner, Andrea Haid - ICF as a main idea and real practice in rehabilitation

**11.20 – 12.15 Poster session III/ coffee**

**12.15 – 13.15 Screening of the documentary Speechless**

(www.speechlessdoc.com)

**13.15 Lunch, Excursion and Dinner**

## Thursday, September 29, 2016

**Session four 9.30 – 1300 (Coffee break around 11.00)**

Carlo Miniussi

Julius Fridriksson

Mieke van de Sandt

Discussant: Roelien Bastiaanse

**13.00 - 15.00 Lunch**

**15.00 – 17.00 Contributed papers IV (executive functions, working memory and intervention)**

17. Claire Penn, Nancy Barber, Peter Fridjhon -Early recovery profiles of language and executive functions in bilingual persons following brain injury

18. Anna Stielow, Prisca Stenneken & Eva Belke- Behind executive functions -the role of linguistic components in word generation tasks.

19. Lilla Zakariás, Christos Salis, Isabell Wartenburger - Investigating transfer effects after working memory training in aphasia

20. Jade Cartwright, Anne Whitworth, Ashleigh Beales, & Suze Leitão - Trialling a multilevel approach to improving discourse in Primary Progressive Aphasia: A pilot study

21. Franziska Machleb - Comparing the effectiveness of errorless and errorful learning in naming therapy in aphasia. What do you like to improve?

22. Anne Whitworth, Suze Leitão, Jade Cartwright, Janet Webster, Graeme Hankey, Jan Zach, Vanessa Wolz & Bob Kane - Generalisation following a multilevel discourse intervention: Is conversation really the gold standard?

## Friday, September 30, 2016

**Departure**

# Frequency and strength of word collocations distinguish speakers with fluent aphasia, non-fluent aphasia, right hemisphere damage and non-brain-damaged controls

Vitor C. Zimmerer[1], Loveday Newman[1], Rosalind Thomson[1], Rosemary A Varley[1]

[1]*Department of Language and Cognition, University College London*

## Introduction

Aphasic speakers often retain formulaic language (Code, 1982): they may be able to produce a form like *I don't know*, but not forms of similar structure like *I don't agree*, or even syntactically simpler structures like *I know*. Word combinations that occur very often or have idiomatic functions tend to be easier to understand and produce, and are more resilient to brain damage. While everyone uses language formulas, neurological damage can result in deviation from typical use. An increase in formulaicity can indicate damage to creative combinatorial systems, limiting the individual's ability to generate novel expressions and therefore adjust to new communicative situations.

In our project we focused on frequency of use and collocation strength (computed on the basis of frequencies) as indicators for the degree of formulaicity in an individual's language output (Wray, 2012) and as markers of pathological language. Frequency of use effects have been systematically investigated in healthy speakers (e.g., Tremblay & Baayen, 2010) and are currently debated in aphasia (Gahl & Menn, in press). Frequency-based variables carry much potential for clinical research and practice. They can be extracted in a computerized and automated manner, which may make them useful for diagnosis and tracking change. We investigate if frequency and collocation strength of word combinations strength (a variable based on frequencies) can distinguish pathological populations. We have developed a computerized tool for automatic analysis of word combinations using frequency-based variables.

## Methods

### *Participants*

We analyzed semi-structured interviews from people with fluent aphasia (FA), non-fluent aphasia (NFA), right hemisphere damage (RHD) and non-brain-damaged controls (NBD). Each group contained 10 speakers. Participants were asked about life events including their stroke story.

### *Methods*

Transcripts were analyzed using the *Frequency in Language Analysis Tool (FLAT*; Zimmerer & Wibrow, 2015; Zimmerer, Wibrow, & Varley, accepted). The FLAT extracts each word, bigram (two-word-combination) and trigram (three-word-combination) and computes frequency of use and t-scores (as a measure of collocation strength) on the basis of the spoken portion of the British National Corpus (2007;

*BNC*). The spoken BNC contains 10 million words that can be seen as one representation of typical language use. The sentence *I don't know*, for instance, is the most frequent finite clause in the corpus.

Transcripts received minor format changes which ensure that only grammatical combinations were analyzed. We also computed connected speech measures on the basis of FLAT data. An additional script was used to calculate the proportion of closed-class words.

# Results

FLAT data, and in particular a combination of t-scores and frequency, distinguished all four groups from each other. People with aphasia were the most formulaic, followed by NBD controls and people with RHD. People with aphasia significantly differed from the other groups, and from each other, with regards to connected speech and proportion of closed-class words.

# Discussion

Despite "merely" using frequency-based variables, and not accounting for idiomatic use, the results support previous findings on formulaic language (van Lancker Sidtis & Postman, 2006). Formulaic language is indicative of a language system which cannot be described by "words and rules" alone. Rather, we propose a lexicon-syntax continuum in which multiword utterances can be lexicalized to different degrees (e.g., Goldberg, 2003).

# References

Gahl, S., & Menn, L. (in press). Usage-based approaches to aphasia. *Aphasiology*.

Goldberg, A. E. (2003). Constructions: a new theoretical approach to language. *TRENDS in Cognitive Sciences, 7(5),* 219–224.

Van Lancker Sidtis, D., & Postman, W. A. (2006). Formulaic expressions in spontaneous speech of left- and right-hemisphere-damaged subjects*. Aphasiology, 20*(5), 411–426.

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Wray, A. (2012). What do we (think we) know about formulaic language? An evaluation of the current state of play. *Annual Review of Applied Linguistics, 32*, 231–254.

Zimmerer, V. C., & Wibrow, M. (2015). Frequency in language analysis tool.

Zimmerer, V. C., Wibrow, M., & Varley, R. A. (accepted). Formulaic language in people with probable Alzheimer's Disease: a frequency-based approach. *Journal of Alzheimer's Disease*.

# Morphosyntactic production in Greek and Italian probable Alzheimer's disease: Evidence from agreement, tense, and mood

Valantis Fyndanis[1,2] Dimitra Arfani[3] Francesca Burgio[4,5]
Anna Maculan[4] Fabio Palla[4] Spyridoula Varlokosta[3]
Sokratis Papageorgiou[3] Annachiara Cagnin[4] Carlo Semenza[4,5]

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[5]*IRCCS S Camillo, Lido di Venezia, Italy*

## Introduction

The majority of linguistically-oriented studies on probable Alzheimer's disease (pAD) focus on the lexical-semantic domain, which is found largely impaired. To date, only a few studies have investigated morphosyntactic abilities of pAD individuals, and their results are contradictory. Recently, Fyndanis et al. (2013) reported a selective verb-related morphosyntactic deficit in Greek pAD (Agreement>Tense>Aspect, in production) and employed the *Interpretable Features' Impairment Hypothesis* (IFIH) (e.g., Fyndanis et al., 2012), originally formulated in aphasia research, to account for it.

This study addresses the questions (1) whether indeed verb-related morphosyntactic phenomena are selectively impaired in pAD and (2) whether hypotheses developed in aphasia research can also explain pAD results. We investigated the ability of Greek- and Italian-speaking individuals with pAD to produce Agreement, Tense, and Mood. Three hypotheses will be discussed here:

(1) IFIH: According to this hypothesis, Tense and Mood (both +interpretable) are expected to be more impaired than Agreement (–interpretable) in both languages.

(2) *Tense Underspecification Hypothesis* (TUH) (Wenzlaff & Clahsen, 2004, 2005): Mood and Agreement will be better preserved than Tense in both languages.

(3) *Distributed Morphology Hypothesis* (DMH) (Wang et al., 2014): The DMH posits that what is impaired in agrammatic aphasia are categories involving inflectional alternations; moreover, these categories are comparably affected. Thus, this hypothesis would predict the three categories to be equally impaired in Italian and selectively impaired (Mood>Tense/Agreement) in Greek. (Note that the subjunctive Mood is encoded through a free-standing morpheme in Greek and through inflectional suffixes in Italian.)

# Methods

## *Participants*

We tested 16 Greek-speaking and 12 Italian-speaking individuals with mild-to-moderate pAD. We also tested two age-and education-matched control groups, which performed significantly better than the pAD groups. Their performance, thus, will not be considered here.

## *Materials*

In both languages, we used a sentence completion task to test Agreement and Tense (SCT1) and another one to test Mood (SCT2). SCT1 consisted of 80 items, half of which tested Agreement and half Tense. Participants were auditorily presented with a source sentence (SS) and the beginning of a target sentence (TS). They were instructed to orally complete the TS producing the missing verb phrase (VP). Examples of the Agreement and Tense conditions are given in (1a) and (1b), respectively. (Only the English translations are given here.)

(1a) SS: Tomorrow you will wash-2nd.sg your hair.
TS: Tomorrow he _____. (target: *will wash-3rd.sg his hair*)

(1b) SS: You tomorrow will wash your hair. (lit.)
TS: You yesterday _____. (lit.) (target: *washed your hair*)

SCT2 included 60 experimental items, half of which tested indicative Mood and half subjunctive Mood. The design of SCT2 in the two languages was not identical since Greek and Italian encode Mood in different ways.

In Greek, participants were presented with a picture depicting an action and two persons, and one two-clause coordinate sentence or two one-clause sentences. The experimenter started describing what was happening in the accompanying picture initially focusing on one of the two persons and then directing the participant's attention to the second person. At some point the experimenter interrupted her utterance and the participant had to complete the experimenter's utterance providing the missing VP. Examples of indicative and subjunctive Mood items are given in (2a) and (2b), respectively.

(2a) *To korítsi θéli na kolibísi, enó to aγóri*_____. (target: *kolibái*)
The girl wants to swim, while the boy_____. (target: is swimming)

(2b) *To korítsi kolibái. Ce to aγóri θéli*_____. (target: *na kolibísi*)
The girl is swimming. Also the boy wants_____. (target: to swim)

In the Italian version of SCT2, which did not involve pictures, all experimental items were conditional sentences. Participants were cross-modally presented with a sentence, in which the target verb form was missing from the subordinate clause. The missing verb was substituted by an underscore symbol and the infinitival form of the missing verb appeared within parentheses below the sentence. Participants were asked to orally provide the correct verb form. Examples of subjunctive and indicative Mood items are given in (3a) and (3b), respectively.

(3a) Comprerei l'auto nuova, se _____ la lotteria. (vincere) [target: vincessi]
'I would buy a new car, if I _____ the lottery. (win) [target: won]

(3b)Compro l'auto nuova, se _____ la lotteria. (vincere) [target: vinco]
'I will buy a new car, if I _____ the lottery.' (win) [target: win]

# Results

The Greek-speaking pAD participants performed significantly worse on Tense than on Agreement (Wilcoxon test; $p<.05$) and Mood ($p=.05$). Agreement and Mood did not dissociate. A different pattern was exhibited by the Italian-speaking pAD participants, as they performed significantly worse on Mood than Agreement ($p<.01$) and Tense ($p<.01$), with the last two categories eliciting comparable performances (Fig. 1).

# Discussion

Consistent with Fyndanis et al. (2013), the results indicate that verb-related morphosyntactic phenomena are selectively impaired in pAD.

The pattern observed in Greek pAD (Agreement/Mood>Tense) cannot be accounted for by the IFIH (e.g., Fyndanis et al., 2012), because Mood (+interpretable) was found well-preserved. The Greek results are not in line with the DMH (Wang et al., 2014) either, as this hypothesis predicts no dissociation between Tense and Agreement. (Both categories involve inflectional alternations.) However, the pattern observed here can be accounted for by the TUH (Wenzlaff & Clahsen 2004, 2005).

None of the three hypotheses are consistent with the Italian data (Tense/Agreement>Mood). The IFIH does not capture the Italian results, since Tense (+interpretable) was as impaired as Agreement (–interpretable). The TUH would predict Tense to be more impaired than Mood and Agreement, and not as well-preserved as Agreement or better preserved than Mood. Lastly, the DMH does not explain the Italian results, as it would predict Agreement, Tense, and Mood—which all three involve inflectional alternations—to be equally impaired.

Taken together, the Greek and Italian results suggest that, in mild-to-moderate pAD, selective morphosyntactic deficits emerge cross-linguistically. Nevertheless, the patterns of performance are not consistent across languages but appear to be determined by language-specific properties. Thus, none of the recent hypotheses proposed for agrammatic aphasia can capture cross-linguistic AD patterns of morphosyntactic production.

# References

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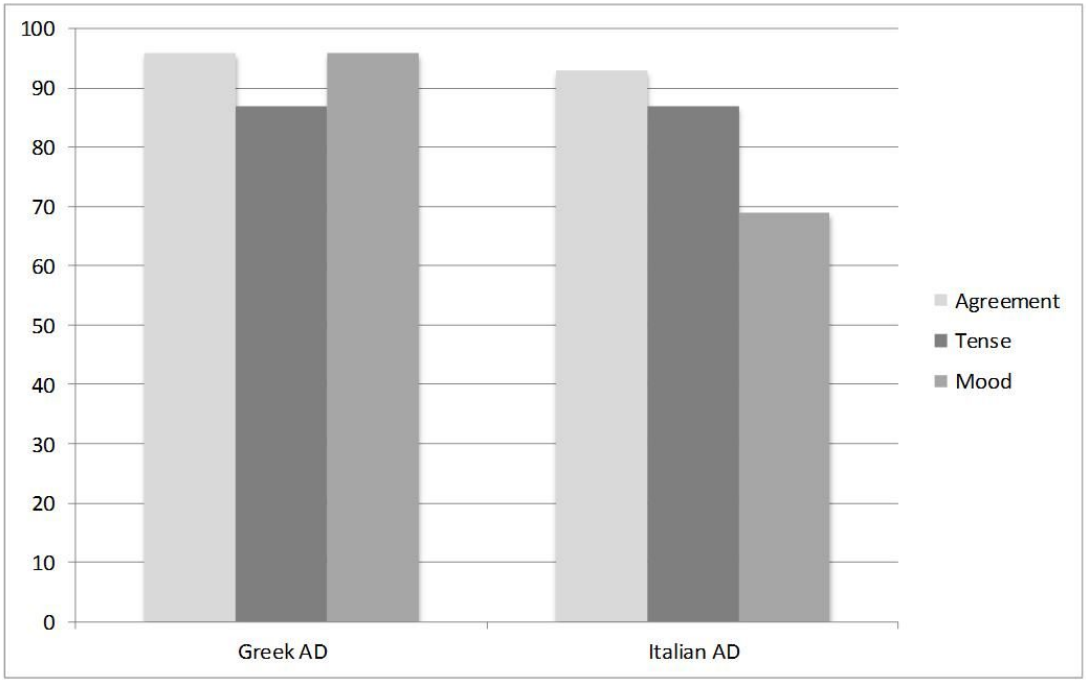


**Fig. 1**. Percent accuracy scores for Greek- and Italian-speaking pAD.

# Grammatical structures in agrammatism: a usage-based investigation of multi-word expressions

Heilemann, C.[1], Varley, R.[1], Zimmerer, V.[1], Carragher, M.[2], & Beeke, S.[1]

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# Introduction

The productive language of people with agrammatism is characterized by one-word or short multi-word utterances and a lack of inflectional markers, prepositions, verbs and copulas (Goodglass, Kaplan, & Barresi, 2001). The multi-word utterances produced by speakers with agrammatism often reflect formulaic expressions (FEs). FEs (e.g., "*wait a minute*") are common and frequently used phrases in typical spoken discourse (see e.g. Wray, 2002). Such utterances are often neglected in analyses of elicited speech, and investigations that systematically explore FEs are rare in aphasia. Within data drawn from real-life interactions, conversation analytic work has shown that some of the FEs (e.g., "*I suppose*") can serve as a conversational resource for people with agrammatism (Beeke, 2003). In a parallel development, usage-based theories of grammar (Bybee, 2010) have gained considerable attention in linguistics in recent years. Usage-based theories propose that constructions like FEs represent a basic linguistic unit, and that experience with language (i.e., language usage) shapes a speaker's individual grammar. The usage-based perspective shows great potential in offering new insights into agrammatic language processing. It stands in contrast to the traditional 'words and rules' view (Janssen & Barber, 2012). However, to date, usage-based theories have not been applied to the connected speech of people with aphasic syndromes such as agrammatism. The current study seeks to outline and discuss a frequency-based perspective to multi-word expressions produced by speakers with agrammatism in different conversational settings. It explores profiles of FEs in people with agrammatism and their neurotypical conversation partners (CPs) when interacting in naturalistic conversations. Furthermore, the degree of formulaicity in the speakers with agrammatism in everyday interactions and clinical settings (semi-structured interviews) is compared.

# Methods

## *Data*

Data consisted of 5-minute samples from everyday conversational data from nine dyads, in each case a person with chronic agrammatism and their CP. Data from eight dyads were taken from a project by Carragher et al (2015) and the remaining dyad stems from a UCL digital audio-visual archive 'CAVA'. The

AphasiaBank database (MacWhinney et al., 2011) served as a source for non-dyadic talk (semi-structured interview samples) from 39 speakers with agrammatism.

### *Procedure*

Transcriptions were analyzed based on frequency estimates and related variables, using the '*Frequency in Language Analysis Tool*' (FLAT) developed by Zimmerer & Wibrow (2015; see also Zimmerer, Wibrow, & Varley, accepted). This automated analysis tool compares words, two-word- and three-word combinations in a test corpus to a reference corpus, the 10-million-word spoken subcorpus of the British National Corpus (2007). Variables of interest included word and phrase frequency and related corpus linguistic variables such as t-scores (measures of the degree of association between the units of a two- or three-word combination). This permits estimation of the likelihood that a word combination is an FE; the higher the t-score, the higher the degree of association between the units of a word combination (e.g., "*it's alright*" has a t-score of 28, whereas "*it's new*" has a t-score of 4). In addition to these frequency-related variables, measures of verbal productivity were used, including the proportion of multi-word utterances out of the total number of words produced, and the rate of closed class words. Analyses focused on differences between people with agrammatism and their CPs in naturalistic settings, and a comparison of agrammatic profiles of FEs in naturalistic versus clinical settings.

## Results

The language output produced by people with agrammatism in comparison to their CPs was best distinguished quantitatively at the level of three-word combinations, indicating a higher degree of formulaicity in word combinations observed in people with agrammatism. The analysis of the rate of closed class words indicated a similar proportion of function words in both speaker groups. This finding might be related to the restricted set of word combinations available to people with agrammatism who present with a high degree of formulaicity. Moreover, comparisons of frequency-related measures between the conversational settings (everyday conversation versus semi-structured interviews) were made, and the findings suggest that the frequency-based profiles of both settings are similar.

## Discussion

This report demonstrates the value of a frequency-based perspective on the multi-word utterances produced by people with agrammatism and outlines those variables that characterize agrammatic profiles of FEs. This novel perspective on the connected speech of people with agrammatism is in line with usage-based theories, providing one of the first applications of such approaches to the connected speech of people with agrammatism.

## References

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# Lexical, morphological, and syntactic abilities in patients with Semantic Dementia

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## Introduction

Recent studies on semantic dementia (henceforth SD), a type of primary progressive aphasia (PPA) indicate that lexical/semantic deficits constitute a hallmark of the disease. As far as the morphological and syntactic abilities of patients with SD are concerned, the evidence is highly inconsistent. On the one hand, drop in lexical-semantic knowledge is reported in face of spared morphosyntactic abilities (Kavè et al., 2007) while on the other hand, impairments in the domain of morphosyntax in SD were found (e.g. Auclair-Ouellet et al., 2016) and interpreted as indicative of the disease progress (Bright et al., 2008). These findings suggest that the morphosyntactic abilities as well as their relation to lexical abilities deserve more scrutiny.

Taking into account the findings above, our study has been designed to shed light in lexical, morphological and syntactic abilities by testing a Greek speaking sample of patients with SD. It particularly focuses on whether deficits in the domains of morphology and syntax appear alongside with lexical deficits.

## Methods

### *Participants*

Eight patients (Mean chronological age: 68;4; SD: 6) recruited from the 2nd Neurological Clinic of the University of Thessaloniki participated in this study. The patients have been diagnosed with semantic PPA in accordance to the criteria proposed by Gorno-Tempini et al. (2011). They were assessed by the means of Addenbrooke's Cognitive Examination-Revised (ACER) standardized for Greek population (Konstantinopoulou et al., 2011). The overall ACER score constitutes a measure for disease severity: the lower the ACER score, the more advanced disease stage. Further assessment by the means of the Greek version of Boston Diagnostic Aphasia Examination (Tsakpini et al.,2010) indicated lexical retrieval difficulties in the naming task. The patients were matched to eight healthy controls on chronological age, years of education, and gender.

### *Materials*

We employed the following materials to test the lexical, morphological and syntactic abilities of SD patients and control participants.

To assess their expressive lexical abilities, we employed a part of the Greek version of the *Word Finding Vocabulary* Test (Vogindroukas et al., 2009). The participants had to name 25 objects presented in pictures.

To assess the participants' morphological abilities, we used the *Perfective Past Tense Test* (PPTT) extensively employed by Clahsen and Stavrakaki (e.g. Stavrakaki & Clahsen, 2009; Stavrakaki et al., 2010) to investigate the production of regular (=sigmatic) and irregular (=non-sigmatic) past tense in Greek speaking population. This is an elicited production task supported by pictures and designed to elicit existing and novel sigmatic and non-sigmatic past tense forms. In the present study, we employed the materials for existing sigmatic and non-sigmatic forms. The participants had to produce in total 20 past tense forms (10 sigmatics and 10 non-sigmatics).

To assess the participants' syntactic abilities, we employed an elicited task for the production of wh-questions developed by Stavrakaki and collaborators (e.g. Stavrakaki et al., 2011). In this task, oral scenarios were presented to the participants in order for them to produce subject and object wh-questions. For the needs of the present study, we employed the materials for object wh-question elicitation, as object wh-questions constitute a crucial marker for impaired syntactic abilities in Greek speaking clinical samples (for a review, Stavrakaki, 2005). Each participant had to produce 9 object wh-questions.

# Results

All controls showed a ceiling or near ceiling performance. The patients' performance on the experimental tasks is shown in Table 1.

Table 1. The SD patients' performance (%) on the experimental tasks

| Group | Word Finding Vocabulary Mean (SD) | Production of sigmatic past tense Mean (SD) | Production of non-sigmatic past tense Mean (SD) | Production of object wh-questions Mean (SD) |
|---|---|---|---|---|
| SD patients | 59 (32.12) | 92.5 (7.07) | 70 (16.90) | 59.72 (33.03) |

The results confirm that impairments in the domain of expressive vocabulary is a core feature of the SD patients' performance as significantly lower performance was shown by the patients compared to the control group ($Z$= 2,5, $p$=.013). Furthermore, the study revealed difficulties in the domain of wh-question production. Specifically, the patients' performance was significantly lower than that of the controls ($Z$=2,475, $p$=.016). Remarkably, error analysis indicated the production of syntactic errors such as gap filling errors and production of subject instead of object wh-questions.

Another asymmetry between the performance of the SD group and the control one concerned the within group differences in the production of sigmatic and non-sigmatic past tense. While the SD

patients performed significantly better on the sigmatic (=regular) past tense ($Z$=2.26, $p$=.024), no such difference was attested for the control group.

In addition, correlation analysis (Spearman's rho) revealed moderate correlation between the patient ACER scores and the correctness scores for wh-questions (*rho*=.65). This finding indicates that a low ACER score implicates low correct performance on the production of object wh-questions.

# Discussion

Overall the findings indicate consistent difficulties in lexical abilities. On the one hand, lexical retrieval was impaired in the lexical production task (object naming test). On the other hand, the correctness level for the non-sigmatic (=irregular) past tense production was significantly lower than that for the sigmatic (=regular; *rule based* form) past tense. This finding indicates a decay in irregular past tense form retrieval in SD. Interestingly, difficulties with object wh-questions as well as production of pure syntactic errors, such a gap-filing errors, related to wh-operator movement, highlight the grammatical difficulties of these patients. Notably, these difficulties are more evident for patients being at an advanced stage of the disease.

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# Processing Complex pseudo-words in Primary Progressive Aphasia and Agrammatic Aphasia

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## Introduction

Individuals diagnosed with the agrammatic variant of Primary Progressive Aphasia (PPA-G) present with nonfluent speech (i.e., reduced words per minute and utterance length), grammatically impoverished sentences and verb production difficulties, with noted deficits in both production and comprehension of complex syntactic structures (Thompson et al., 1997). Despite the neuropathological differences between PPA-G and stroke-induced agrammatic aphasia (StrAg), the two groups demonstrate similar language deficits mainly in the syntactic domain (Thompson, Lukic et al., 2013; Thompson, Meltzer-Asscher et al., 2013) and in particular, the processing of argument structure (see Thompson et al., 2012 for PPA-G; Thompson et al, 2010; Bastiaanse & Jonkers, 1998 for StrAg). At the lexical level, although inflectional morphology is compromised across groups (Thompson, Meltzer-Asscher et al., 2013), few studies have investigated derivational morphology in StrAg only (Faroqi-Shah & Thompson, 2010; Miceli et al., 2004) yielding inconclusive results.

The current study investigates whether individuals with PPA-G and StrAg are able to detect violations of argument structure and syntactic category in *pseudo-words* formed with the prefix *re-,* such as **rehappy* vs. **resmile.* In healthy populations, morphological information is accessed immediately on encountering a complex lexical item (Rastle & Davis, 2008; Fruchter et al., 2013), however, little work has addressed what kind (e.g., grammatical category; thematic information) and how much information is accessed once initial decomposition and morpheme recognition has taken place. In a recent lexical decision study by Manouilidou & Stockall (2014), Greek- and English-speaking participants were presented with pseudo-words which violated word formation rules in both languages, in an attempt to tease apart the contribution of syntactic category and argument structure information in building deverbal (verb derived) word formations. Results revealed distinct RTs and accuracy rates for each type of pseudo-word, suggesting that participants from both languages processed each type of information (syntactic category vs. argument structure) at distinct stages, isolating their contribution in word formation - finding confirmed by Slovenian speakers as well (Manouilidou et al, 2015).

The aim of the present study is to assess the ability of individuals diagnosed with PPA-G and StrAgr to detect violations in word formation, especially when these rely on the syntactic category (**rehappy*) of the base and on argument structure information (**resmile*), areas shown to be problematic for both populations. Specifically, we predict that while both populations would have no difficulties rejecting violations of syntactic category, they would tend to accept more violations of argument structure given their deficit in this domain.

# Methods

## *Participants*

Seven individuals with StrAg (mean age: 42, SD: 13.4), five individuals PPA-G (mean age: 69, SD: 5.7) and seven age-matched controls (AM), all English-speaking.

## *Materials and design*

An auditory lexical decision task was developed, including four experimental and three filler conditions, with 40 items each. Materials comprised 2 groups of words violating constraints of word formation in English (A & B), novel words without violations (C), and real words (D). All were formed with the prefix *re-*. Materials were based on Manouilidou & Stockall (2014).

A. Pseudowords with grammatical category violations (**re-happy*) (re- prefix cannot be used with adjectives in English)
B. Pseudowords violating thematic constraints of the base (**re-smile*) (re- prefix cannot be used with intransitive verbs in English)
C. Novel words without violations (*rehold*) (re- prefix is used with some, but not all two argument verbs, e.g., reexamine)
D. Real word derived forms (*reinvest*)

76 well-formed words were used as fillers; 46 contained decomposable (e.g., *un-dress*) and 30 non-decomposable affixes (e.g., *recruit*). All words used across conditions were matched on length and on CELEX stem/root frequency.

## *Procedure*

Participants were instructed to indicate whether or not the auditory presented word was a real word by pressing one of two pre-specified buttons on the keyboard.

# Results

Figure 1 shows percentages of correct responses (upper half) and RTs (lower half). With respect to **accuracy**, a 3 (group) by 4 (condition) ANOVA revealed a main effect of group ($p<0.02$), a main effect of condition ($p<0.001$) and no significant interaction. Subsequent post-hoc comparisons revealed significant differences between PPA-G and AM groups in all four conditions, StrAg and AM groups in CatViol and Real Word conditions, and PPA-G and StrAg in all conditions except Real words. With respect to **RTs,** analysis revealed a main effect of group ($p<0.001$), a main effect of condition ($p<0.001$) and a significant interaction ($p<0.01$), while post-hoc test showed that the only significant difference between AM and both PPA-G and StrAg groups was in the ThemViol condition, suggesting that AM pondered longer in the view of this category (**resmile*). Within each group, the critical difference between CatViol and ThemViol in PPA-G is not significant, neither in accuracy nor in RTs. For StrAgr, the difference is significant in accuracy but not in RTs.

# Discussion

The main findings of the study can be summarized as follows:
a. the PPA-G group was worse than the AM and StrAg groups across conditions in terms of accuracy, revealing an inability to distinguish between grammatical category and thematic violations, or between thematic violations and novel word forms.
b. the lack of significant difference between StrAg and AM in ThemViol suggests that the former group has no difficulties detecting argument structure violations *within* the word.
c. the difference between StrAg and AM in categorial violations suggests that StrAg might have more difficulties with the detection of syntactic category.

Although PPA-G and StrAg have more-or-less the same profile, including difficulties with argument structure, it seems that at word level, StrAg can implement their knowledge and detect the violations in the same way as controls. PPA-G on the other hand, demonstrate exactly the same behavior as they do at sentence level, that is, inability to process argument structure information correctly. Although still preliminary, this might indicate that the argument structure difficulties of these two populations at sentence level reflect a different source of the same problem. Namely, argument structure difficulties in StrAg could be a by-product of a processing difficulty while for PPA-G the result of loss of knowledge about verb argument structure and other information related to a word. This issue calls for further investigation.

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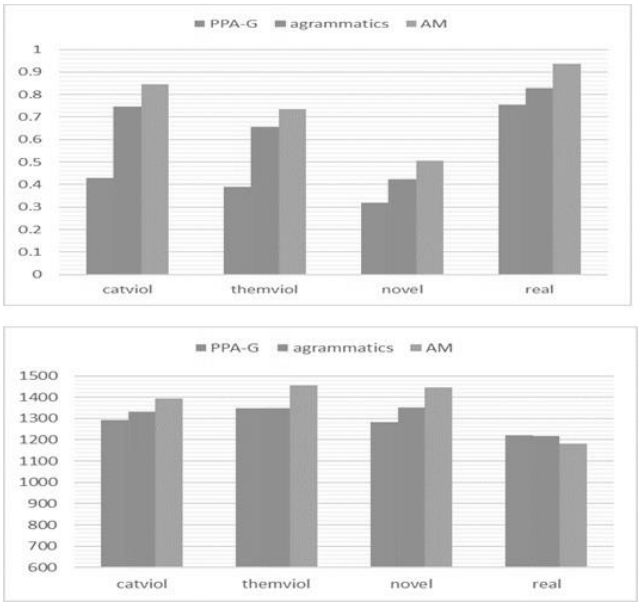


Figure 1: percentages of correct responses and RTs per condition by all three groups.

# The role of morphology and prosody in agrammatic comprehension

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## Introduction

Agrammatic patients are known to have difficulties in comprehending certain structures. The goal of the present study was to examine whether the presence of distinctive morphosyntactic and prosodic features can influence the agrammatics' comprehension of these structures. To this purpose, we carried out two sentence-picture matching tasks on the comprehension of declarative sentences (1a), contrastive focus (1b) and clitic left dislocation (1c) in Catalan, and a discrimination task to test the aphasics' perception abilitites.

| | | | |
|---|---|---|---|
| (1) | a. | La pallasso va amagar els nens.<br>D-fs clown-s past-3s hide D-mp boy-p<br>"The clown hid the boys." | declarative (SVO) |
| | b. | ALS NENS, va amagar la pallasso.<br>"THE BOYS, the clown hid." | contrastive focus (OVS) |
| | c. | Als nens, els va amagar la pallasso.<br>"The boys, the clown hid them." | clitic left dislocation (OclVS) |

To our knowledge, there are only two studies concerning the perception of intonational contours by German-speaking Broca's aphasics, Burchert et al. (2005) and Raithel (2005), and none on the Romance languages. Catalan, unlike German, has some interesting structural properties for that purpose: different syntactic constructions can present the same word order and, therefore, it allows for intonation to be the only variable over different structures. The question is particularly relevant given that sentential meaning is partly conveyed by prosody (Pierrehumbert, 1999).

On the morphosyntactic side, the role of case morphological cues in aphasic comprehension has already been tested in Hebrew, German and Russian (Friedmann and Shapiro, 2003; Burchert et al., 2003; 2005 and Friedmann et al., 2010). Catalan differs from previously tested languages in that only pronouns display overt Case markers, and we examined the role of other morphosyntactic features, such as gender and number, and the presence of a resumptive clitic in agreement with the displaced object in clitic left dislocations (1c).

# Methods

## *Discrimination task*

A discrimination task was designed and conducted with 10 Broca's aphasic subjects (age range 23–81, diagnosed as suffering from Broca's aphasia except for one diagnosed with global aphasia, etiology: HCVA or ICVA) and 10 age- and education-matched control subjects. Pairs of utterances were presented to the participants who were asked to say whether they though them to be identical or different. The pairs combined four different sentences: neutral declaratives, yes-no questions, contrastive focus and topicalizations, all identical in word order but different in intonational contour.

## *Comprehension tasks*

Two sentence-picture matching tasks on the comprehension of contrastive focus and clitic left dislocation were carried out with 7 and 9 aphasic participants (age range 38–80, diagnosed as suffering from Broca's aphasia except for one diagnosed with global aphasia, etiology: HCVA or ICVA) respectively, along with 7 and 9 age- and education-matched control subjects. In focalisations, the subject and object did not match in number and gender (1b), whereas in dislocations only half of the items presented mismatch of *phi*-features (1c).

# Results

In the intonation discrimination task, the aphasic subjects' performance reached a 89.1% of correct responses, which indicated that agrammatic individuals succeeded in the task, even though their error rate was significantly higher ($\chi 2 = 6.35$; $p < 0.05$) than that of control subjects (4.4%). These results establish that Catalan aphasic individuals are able to discriminate different intonational contours and do not present disrupted phonological abilities in perception.

The results on the comprehension tasks appear in Table 1. The presence of the resumptive clitic did not help agrammatic aphasics to interpret clitic left dislocations, which were understood at chance, like focalised structures (Table 1). In addition, the presence of mismatched morphosyntactic features did not prevent aphasics from failing to interpret object-derived constructions, and their performance did not significantly improve on mismatched sentences over their matched counterparts in the comprehension task on dislocations (OR=0.59, CI (0.32, 1.06)).

# Discussion

By the standard analysis of focalisation, the OVS word order of object focalisations in Catalan is derived by leftward movement of the object to Focus position, and verb raising from V to T. Under this analysis, we would predict object focalisations to result in miscomprehension given intervention effects of the raising of the object over the subject. This prediction is borne out. The syntax of clitic left dislocation is more controversial, but most current accounts also assume a movement analysis of the object, and if so miscomprehension is predicted as in object focalisation. Again the prediction of miscomprehension due to intervention effects is borne out. What our results show is that, despite clear intonational and

| | SVO Declarative | OVS Focus | OclVS CLLD | |
|---|---|---|---|---|
| | | | mismatched | matched |
| **Controls** | **98.66%** | **95.92%** | **96.26%** | **97.78%** |
| **Aphasics** | **94.90%** | **51.02%** | **55.56%** | **42.22%** |

Table 1. Mean percentages of correct responses by condition

morphological cues in the input, to which the patients are sensitive (our discrimination task witnesses to it, and former work shows that morphology is spared in agrammatism), agrammatic patients cannot overcome the syntactic deficit, and so fail to assign semantic roles to (a subset of) syntactic positions.

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# Functional Neuroanatomy of Semantic Aphasia

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# Introduction

Semantic aphasia is regularly diagnosed in clinical settings that utilize Alexander Luria's neuropsychological approach. It is characterized by a lack of problems with respect to speech fluency, auditory comprehension, reading and repetition of single words or simple phrases, but comprehension of particular types of semantically reversible sentences is impaired (Luria, 1947/1970): e.g., prepositional (*Draw a triangle above a circle*), instrumental (*Point to the key with the pencil*), comparative (*Sonja is taller than Katja*) and some others. Luria collectively referred to these as "logical-grammatical constructions" as they required the extraction of the logical relationship between the mentioned persons, objects or events from the grammatical markers within the sentence. He linked this linguistic deficit to an inability to integrate distinct linguistically-mediated elements into a unified, simultaneous, mental representation, and thus conceptualized it as a disorder of a spatial nature grounded in the temporal-parietal-occipital (TPO) regions of the brain.

With the goal of investigating the neuroanatomy of semantic aphasia in more detail, we studied 10 contemporary patients with semantic aphasia. We provide both their neuropsychological profiles and lesion neuroimaging data including the extent of white matter involvement, data that were not available to Luria at the time of his historical reports.

# Methods

## *Participants*

All patients were native speakers of Russian, premorbidly right-handed except one relearnt left-handed patient. Their mean age (and range) was 57 years (33-71), education – 13 years (8-15), months post-onset – 22 (2-61); 7 were females. Seven of them became aphasic due to a single left-hemisphere stroke, two had multiple left-hemisphere strokes, and one patient had a stroke in the right hemisphere.

## *Neuropsychological assessment*

According to Luria's classification system (Akhutina, 2015), all patients were diagnosed with mild-to-moderate semantic aphasia. In accordance with Luria's guidelines (1962/1966), the testing of multimodal sensory and symbolic spatial analysis and synthesis can identify difficulty in (quasi) spatial processing. Thus, the used tests probed the comprehension of logical-grammatical constructions and figurative linguistic expressions, reading and writing, spatial constructional praxis, visual spatial gnosis, somatospatial praxis, and calculation.

### *Brain imaging*

The structural MRI data were used to assess the involvement of different cortical and white matter structures in each patient. MRI images were acquired on a 1.5 T Siemens Magnetom Avanto scanner at least three months post onset. For all patients, high-resolution T1 images were obtained using an MPRAGE sequence with 1 mm isotropic voxel. T2 images and FLAIR images were also available for all patients except one. The lesions were delineated using primarily the T1 images, and T2 and FLAIR images, when available. The involvement of specific anatomical structures in the overlay masks, as well as in individual lesion masks, was mapped with the Automated Anatomical Labeling (AAL) and Natbrainlab (http://www.natbrainlab.co.uk/) atlases. The resulted lesion mapping was further compared to Luria's list of brain structures (Luria, 1947/1970) claimed to be involved in semantic aphasia.

## Results

All 10 patients were impaired in the comprehension of logical-grammatical constructions. Interpretation of metaphors and proverbs was problematic for six patients only. Seven patients had impaired writing; in most cases it was accompanied by a facilitating strategy to speak words out by sounds or syllables. Reading was basically spared in all patients, but four patients featured slowed, chanting reading by syllables. In the non-linguistic domains, spatial constructional praxis was the only function that was consistently impaired in this cohort of patients. Visual spatial gnosis was compromised in seven of the ten patients. Somatospatial praxis was found impaired in five of them. Seven patients were impaired in calculation: even if they were able to perform simple arithmetic operations, comparison of numbers and extended math tasks were problematic.

Mapping the lesion overlays to the AAL atlas resulted in identification of the following affected cortical areas in at least four patients: left angular gyrus, left middle occipital gyrus, left inferior parietal lobule, left middle temporal gyrus, left inferior occipital gyrus, left superior parietal lobule, left supramarginal gyrus, left postcentral gyrus. The first five areas belonged to those named by Luria (1947/1970) as involved in semantic aphasia. The lesion overlay analysis also revealed a list of impaired left white matter pathways, which were: arcuate fasciculus (anterior, posterior and long segments), corpus callosum, corticospinal tract, inferior longitudinal fasciculus, internal capsule and optic radiations.

## Discussion

Most patients were not consistently impaired in all the tested domains. However, every patient in this group, in addition to the obligatory impairment of logical-grammatical constructions comprehension and spatial constructional praxis, showed deficits in at least several other relevant domains. Critically, the quality of the errors confirmed that the underlying reason for these deficits was of a spatial nature. These data show that semantic aphasia as a linguistic impairment is also accompanied by disorders in other cognitive domains, but not necessarily by all of them. The most consistent accompanying

impairment is spatial constructional praxis, the most optional being the impairment of somatospatial praxis.

As for the lesion analysis, most of the patients had left TPO lesions and thus followed Luria's predictions. However, the additional analysis of subcortical portions of the lesions, especially in non-prototypical cases of semantic aphasia (in which the left TPO area was relatively intact) suggested that white matter damage might play an important role in the syndrome, and at least two associative pathways – the inferior longitudinal fasciculus and the arcuate fasciculus – can be implicated in the linguistic and non-linguistic deficits of patients with semantic aphasia.

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# Verb comprehension in post-stroke aphasia: A novel verb semantic battery

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## Introduction

There has been a growing interest in the aphasiology literature over the past decades concerning verb deficits. A substantial body of evidence has indicated that verbs, among the other major word classes, pose particular processing challenges in comprehension and retrieval for individuals with post-stroke aphasia (PSA) (e.g., Jonkers & Bastiaanse, 1996; Mätzig et al., 2009). The majority of studies in the field of aphasia verb deficits have focused on morphological and syntactic factors. While the effects of semantics and psycholinguistic features on noun processing, have been well established in the aphasiology literature, their influence on verb processing remains unclear. In this study, we aimed to expand our understanding of verb comprehension, and particularly the semantic aspect of verbs, in PSA. The lack of a thorough aphasia battery specifically designed to investigate verb comprehension deficits with focus on semantics and using a well-controlled set of stimuli, matched on the relevant psycholinguistic features, provided the impetus for developing an aphasia battery with a broad coverage of semantic and psycholinguistic features of verbs.

## Methods

### *Battery Construction*

We developed two verb comprehension tests. Firstly, a synonym judgement test, which consists of 80 verb stimuli split evenly into four verb categories: abstract high-frequency, abstract low-frequency, concrete high-frequency, and concrete low-frequency. The test includes maximal variations of imageability and frequency values across conditions. Imageability and frequency values were matched for the stimuli within each trial (i.e., for the probe verbs, the target responses, and the two unrelated distractors). Secondly, a verb picture-to-word matching test, which contains all 100 action verbs from the Object and Action Naming Battery (OANB: Druks & Masterson, 2000), was constructed. This test entails picture-to-word matching with five multiple choice printed words that comprise the target response and four verb distractors, two of which are semantically related to the target response.

We also created a noun-verb matched set using pictures from the OANB. This set consists of 32 nouns and 32 verbs matched simultaneously on multiple psycholinguistic features (i.e., imageability, frequency, familiarity, age-of-acquisition and word length). We then developed a noun comprehension test, which entails picture-to-word matching for the 32 nouns using the same protocol used to develop the verb picture-to-word matching test.

Normative data for these three newly developed tests were collected from 25 healthy control participants (9 males, 16 females), their age ranged between 62 and 87 years (Mean=72.64, SD=5.37). The results revealed high accuracy: 98.65% on the synonym judgment test, with a near celling performance on all four verb categories (>97.8%), 99.52% on the verb picture-to-word matching test, and 99.5% on the noun picture-to-word matching test. Figure 1 illustrates the normative data on the three newly developed tests (grey columns). Additionally, results revealed a high level of item accuracy for all items within the three tests: an average of 98.55% on the synonym judgment test, 99.52% on the verb picture-to-word matching test, and 99.5% on the noun picture-to-word matching test.

## *Participants with Aphasia*

Twenty-five participants with a wide range of chronic aphasia types and severities, resulting from a single left hemisphere stroke participated in this study (14 males, 11 females). Their age ranged between 44 and 87 years (Mean=61.88, SD=13.37). Each participant completed the three tests: verb synonym judgment, verb picture-to-word matching and noun picture-to-word matching.

# Results

Performance on the three newly developed tests were significantly different between the control group (grey columns, Figure 1) and the PSA group (black columns, Figure 1) ($p<0.001$).

A two-way repeated measures ANOVA examining the effects of imageability and frequency on verb comprehension in the synonym judgment test among the PSA group revealed a significant effect of imageability ($F(1,23)=108.86$, $p<0.0001$, $\eta^2=0.826$), with higher scores in response to concrete high-imageable items (Mean=35, SD=5.348) compared to abstract low-imageable items (Mean=25.79, SD=7.33). Results also revealed a non-significant effect of frequency ($F(1,23)=0.16$, $p=0.69$, $\eta^2=0.007$), as responses to high-frequency items (Mean=30.58, SD=6.466) and low-frequency items (Mean=30.2, SD=6.467) were relatively similar. Results further showed a non-significant interaction between imageability and frequency ($F(1,23)=0.31$, $p=0.583$, $\eta2=0.013$).

For the PSA group as a whole, performance on the two picture-to-word matching tests using the matched noun-verb set were not significantly different ($t(23)=0.087$, $p=0.93$), as the mean accuracy on the noun picture-to-word matching test (Mean=29.32, SD=3.61) was similar to the mean accuracy on the verb picture-to-word matching test (Mean=29.28, SD=3.33). A liner regression analysis on the performance during picture-to-word matching tests with different linguistic features entered as predictors (word class, imageability, frequency, age-of-acquisition, familiarity, world length and visual complexity) was significant ($F(1,128)=6.05$, $p=0.015$), with imageability appearing as the only predictor ($B=0.584$, $t=2.46$, $p<0.05$).

# Discussion

Findings from the normative data and clinical performance indicate that the newly developed battery has the potential to discriminate intact from impaired verb comprehension behaviour.

Moreover, using the newly developed battery, results revealed a significant effect of imageability on verb comprehension, in favour of concrete high-imageable verbs over abstract low-imageable verbs. There was, however, an absence of a frequency effect. These findings are consistent with the regression analysis showing that imageability is the only feature that predicts comprehension performance during picture-to-word matching tests. These results are also in line with literature on the imageability effect previously documented on noun processing, whereas a possible frequency effect that has been shown on noun processing is not supported by these results. The current findings suggest that using a well matched noun-verb set on various relevant psycholinguistic features will eliminate all possible psycholinguistic variations between nouns and verbs, and imageability rather than word class will manifest as the most important feature of lexical comprehension. This supports Bird and colleagues' argument (2000) that verb deficits in comparison to nouns reflect the typically lower verb imageability compared to the higher imageability of nouns.

This study contributes to the aphasiology and psycholinguistic literature pertaining to verb deficits, and it provides sensitive measures of verb comprehension deficits across a relatively large number of participants with PSA, that can be used in research and in clinical practice.

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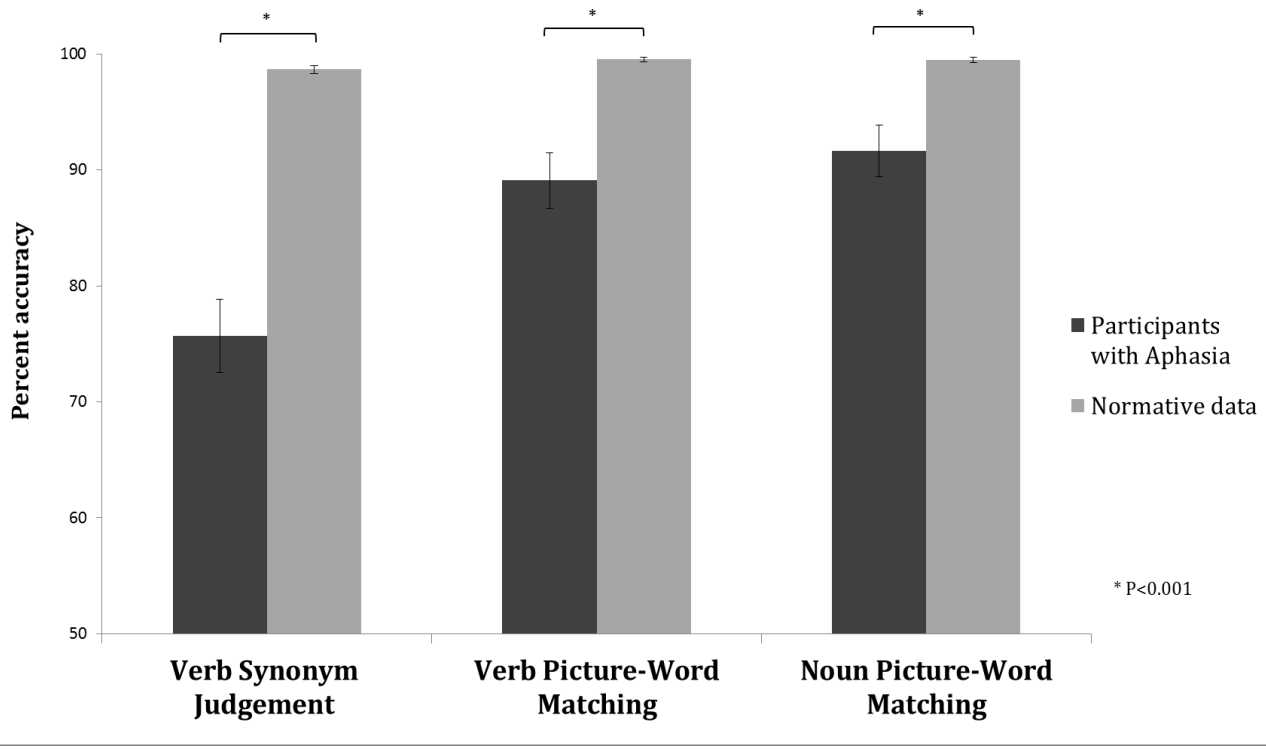
**Figure 1: Performance of participants with aphasia and healthy controls on the newly developed battery**



# Cross-linguistic asymmetries in sentence comprehension deficits in bilingual Basque-Spanish aphasia. Evidence from eye-tracking and behavioural data.

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## Introduction

Cross-linguistic studies offer an important contribution to our understanding of the effect of word order and morphological cue processing in sentence comprehension difficulties of people with aphasia (PWA). Comprehension of semantically reversible sentences presented in derived word order has been proven to be particularly impaired in a large proportion of PWA (for a review see Berndt, Mitchum & Haendiges, 1996). Some studies have shown that PWA speakers of languages with overt case morphology show impaired use of these cues to establish thematic relations in non-canonical sentences (Arantzeta et al. 2016; Hanne, Sekerina, Vasishth, Burchert, & De Bleser, 2011;YarbayDuman, Altinok, Özgirgin, &Bastiaanse, 2011). In Arantzeta et al. 2016, we conducted a sentence comprehension experiment in a group of PWA speakers of Basque, by combining behavioural and eye-tracking methods. We found that PWA are able to compute inflectional morphology without following a guessing pattern. Nevertheless, they still show limitations in predictive processes (see also Hanne et al. 2011, 2015). The evidence suggests that the inconsistent processing of morphological information is the core impairment of patients with agrammatic comprehension. Still, we are far from understanding how language specific properties may modulate the cognitive mechanisms and representations involved in such difficulties.

Cross-linguistically different types of morphological cues (e.g., case/agreement morphology, pre/post-position) may signal the syntactic relations between the constituents of a sentence. It is still not clear if processing different types of morphological cues is equally impaired in PWA. Studies on word order and sentence comprehension in bilingual aphasia are scarce and reduced to single case studies (Munarriz & Ezeizabarrena, 2012; Vaid & Pandit, 1991), but they control for confounds such as inter-subject variability. To gain insight into this topic, we analyse the effect of word order on the sentence comprehension in a group of bilingual PWA speakers of Basque and Spanish.

# Methods

We combined offline (sentence-picture matching) and online (eye-tracking in the visual-world paradigm) methods to analyse a group of seven PWA L1Basque-L2Spanish bilingual speakers and seven healthy control bilingual (NBD) speakers matched for age range, language profile and education level. PWA had preserved lexical comprehension and impaired sentence comprehension. Participants were tested separately in Basque and Spanish with comparable sets of linguistic stimuli. In Basque, both subject and object agreed with the verb and the Agent was marked with the ergative case morpheme *–k*. Sentences were presented in four word orders (SOV, OSV, VSO and VOS). In Spanish the subject agreed with the verb in number and person and the animate Object was marked by the preposition 'a'. The linguistic stimuli were presented in six conditions (active, passive, subject cleft, object cleft, subject relative and object relative). Note that the manipulations for the sentence conditions are different in Basque and Spanish. In Basque the linguistic stimuli varied solely in word order, while in Spanish there were also changes in syntactic constructions. Response accuracy, reaction time and gaze-fixation data were collected. Datasets were clustered in Agent-Theme and Theme-Agent categories to conduct comparable analysis across languages.

# Results

The NBD group performed significantly better than PWA across all conditions. PWA were more accurate in sentences presented in A-T than in T-A argument orders in both Basque and Spanish. Within group analysis showed the PWA group was more accurate in Spanish than in Basque for both A-T and T-A sentences; NBD group were more accurate in Spanish but only for T-A order (see Figure 1). PWA presented shorter RTs in sentences presented in A-T than in T-A order. The NBD group showed the same RT pattern in Basque, but not in Spanish.

Gaze-fixation patterns of PWA in the correct and incorrect answers were different across languages and sentence conditions. In Basque correct answers were characterized by an increase of fixations into the target picture following the auditory presentation of the Subject. In PWA this fixation pattern was delayed in T-A word orders in relation to the NBD group. In the incorrectly answered trials with T-A argument order, PWA presented the inversed fixation pattern of the correctly answered A-T trials. This suggests that PWA use a "subject-first" strategy to disentangle thematic role assignment in sentences presented in non-canonical argument order, which motivates its misinterpretation.

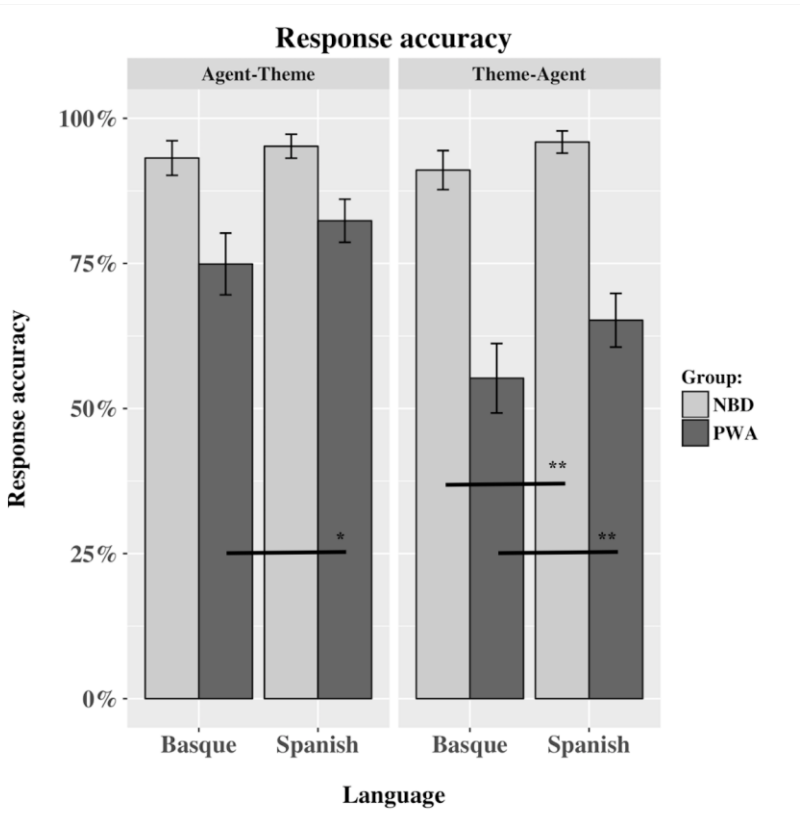


*Figure 1.*Comprehension accuracy (%) in non-brain-damage (NBD) and people with aphasia (PWA) groups as a function of language (Basque/Spanish) and argument order (Agent-Theme/Theme-Agent) within the sentence.

In Spanish, the NBD group presented a gaze-fixation resolution in the second constituent of the sentence (i.e., verb position) across all sentence conditions. In the correctly answered trials, the PWA group showed the same incremental fixation pattern towards the correct picture but in a delayed fashion. In the incorrectly answered trials PWA had an increment of fixations towards the foil picture during the presentation of the linguistic stimuli, as in Basque. Still, in the incorrectly answered trials, the on-line data do not show a regular gaze-fixation pattern suggesting an unequivocal usage of "Subject-first" strategy.

# Discussion

Word order has an effect on sentence comprehension deficits in PWA speakers of two typologically very different languages, Basque and Spanish. The comprehension of sentences is more impaired and slower when presented in T-A order than in A-T order. PWA showed higher accuracy in Spanish than in Basque regardless of the argument order, while NBD showed an advantage to comprehend sentences in Spanish only in T-A order. This suggests that the type of inflectional morphology that needs to be processed influences thematic role assignment on sentence comprehension performance (see Munarriz & Ezeizabarrena, 2011 for converging results). Poorer comprehension in Basque might be due to an

additional processing cost imposed by the ergative case, but also to auditory prominence factors. In addition, correct and incorrect answers in the PWA group show distinctive gaze-fixation patterns and do not support the hypothesis that they are guessing (Hanne et al. 2011). Moreover, both PWA and NBD group show comparable fixation patterns in the correct answers but in a delayed fashion in the case of PWA, supporting a processing slowdown in PWA (Hanne et al. 2011, 2015).

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# Communicative deficits in Traumatic Brain Injury: the relationship between executive and pragmatic impairment

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## Introduction

The neuropsychological assessment of patients with traumatic brain injury (TBI) is typically focused on executive and on Theory of Mind (Tom) impairments. Despite the strict relation with these aspects, little attention is paid to the quantitative assessment of pragmatic/communicative abilities. However, the impairment in these abilities has been largely documented (Stemmer 2008; Honan et al. 2015).Moreover, it may have a relevant impact on the everyday life of both patients and their relatives. The present study addresses the communicative abilities of TBI patients as measured by a newly developed tool, the APACS test (Assessment of Pragmatic Abilities and Cognitive Substrates; Arcara and Bambini, 2016). The aim of this study is to investigate the presence of pragmatic deficits in TBI patients and to study the relationship of these deficits with other cognitive abilities, routinely assessed in the clinical setting.

## Methods

### *Participants*

Two groups participated in the present study: a TBI group and a normal control group. The TBI group consisted of thirty TBI individuals (8 female and 22 male) ranging in age from 17 to 78 years (M=41.46, SD=18.52); their education ranged from 2 to 22 years of schooling (M=12.53, SD=4.47). Twenty-three TBI subjects were recruited from outpatient records of the Physical Medicine and Rehabilitation ward of Vicenza Hospital and seven were patients hospitalized during the period of the research in the same hospital. All participants were Italian native speakers. They were evaluated at least one month post-onset. The time post-onset ranged from one month to 58 months. All TBI participants had no history of other neurological or psychiatric disorders. Information about the brain lesion was obtained by neuroimaging and routine neurological exams. The control group consisted of thirty healthy participants (13 female and 17 male) matched with the patients group for age and years of education.

## *Procedure and Materials*

All participants (TBI and controls) were administered with the APACS test (Arcara & Bambini, 2016). APACS is divided in two sections (production and comprehension) and encompasses six subtests: Interview, Description, Narratives, Figurative Language 1, Humor, Figurative Language 2. Overall, APACS investigates communicative abilities under the theoretical perspective of pragmatics, by focusing on the domains of discourse and non-literal meaning. Additionally, a version of the Token Test was administered to the two groups to assess the language comprehension under a more formal traditional perspective.

TBI patients underwent a further assessment by means of a battery of neuropsychological tests (ENB-2, Mondini et al., 2011), widely employed in Italy. This battery includes, among others, the following tests: Digit Span, Story recall, Verbal Fluency, an Abstraction test, TMT-A, TMT-B, and the Memory with Interference task (a test on working memory).

In the statistical analyses we compared TBI patients and Controls both at a group level (by means of t-tests) and at the individual level, by inspecting the number of patients performing below cut-off in each APACS subtest. In the TBI group we also performed pairwise Spearman correlations between APACS subtests and the neuropsychological tests.

# Results

In the group analysis TBI patients showed a worse performance as compared to controls in all APACS subtests (all *ps* < 0.008). The largest effect sizes (measured by means of Cohen's d) were observed in the Interview (which consists in a checklist made during an interview on autobiographic topics) and in Figurative Language 2 (which consists in a series of items requiring the verbal explanation of figurative expressions). No difference between TBI and controls was observed in the Token Test, showing that the patients were not impaired in formal aspects of language.

A relatively high percentage of patients showed an impaired performance in APACS subtests (i.e. a performance below cut-off) ranging from 33% (in Humor) to 67% (in Figurative Language 2).

The correlations between neuropsychological tests and APACS performance showed significant association of APACS scores with the Memory with Interference, Verbal Fluency, the Abstraction tasks, and Story Recall (all ps < 0.05). A low performance in these neuropsychological tasks was associated with a low performance in APACS. No significant correlation was found between the Token Test and the other neuropsychological tests.

# Discussion

The main aim of the present study was to verify the presence of pragmatic impairments in the clinical population of patients with traumatic brain injury, by employing the newly developed APACS test (Arcara & Bambini, 2016). As a group, patients with TBI showed a worse performance in all pragmatic

tasks as compared to controls. Importantly, in the individual analysis a high percentage of patients showed a performance below cut-off, suggesting that a pragmatic deficit is diffuse and clinically important in TBI. The observed correlations between pragmatic tasks and neuropsychological tests suggest that executive functioning could be one of the cognitive substrates of pragmatic abilities in TBI. In particular, patients with executive impairment seem to be more prone to show a pragmatic deficit and, as a consequence, communicative problems in everyday life. Interestingly, communicative deficits (in production and comprehension) were not accompanied by a relevant deficit in language comprehension as measured with the Token Test, a test traditionally used to measure language comprehension. Future studies could better characterize communicative deficits in TBI patients by studying the relationship of pragmatic abilities with Theory of Mind, the other main domain typically impaired in these patients, known to be strictly related with the pragmatic aspects of communication (Martin & McDonald, 2003; Honan et al. 2015).

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# Impact of concurrent auditory tasks on picture naming in aphasia

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## Introduction

Language production in aphasic participants is usually studied with single tasks. Nevertheless, speaking in everyday conditions is often done at the same time as another task demanding some attentional control. In healthy speakers, it has been shown that a co-occurring task interferes with word planning latencies suggesting that lexical selection and/or word form encoding involve some degree of attentional demand. We have recently shown that non-verbal concurrent auditory stimuli impact on lexical selection whereas verbal auditory distractors impact on both, lexical and post-lexical processes (Fargier and Laganaro, subm). As for aphasic speakers, performance in several linguistic tasks declines under dual-task interference (Murray & al., 1997; McNeil & al., 1991; 2006). The present study aims at investigating how word production in aphasic patients is interfered by a concurrent verbal and non-verbal task as a function of the underlying impairment. According to the results observed in healthy participants and assuming that the effects are magnified in brain-damaged participants, we predict that (1) both, verbal and non-verbal stimuli should impact error rates in aphasic participants with impaired word retrieval, (2) only verbal concurrent tasks should increase error rates in participants with impaired phonological encoding and (3) no effect on errors should be observed on participants with apraxia of speech.

## Methods

### *Population*

Aphasic participants following a focal left hemispheric stroke with mild to moderate anomia. Participants will be divided into groups according to the underlying impairment based on error type and on performance in semantic and repetition tasks.

### *Material and task*

Participants were tested in a picture naming task with 40 line drawings (72 in the healthy speakers' group) in 3 conditions: single naming task, passive dual-task (auditory stimuli to ignore while naming) and active dual-task (auditory stimuli to discriminate while naming). There were 2 types of auditory stimuli: verbal (5 different syllables) or non-verbal (5 different tones) which appeared 300 ms after the onset of the picture. In the active dual-task, participants had to detect a specific syllable/tone, which were all associated to filler items.

# Results

We are currently running the experiment. Preliminary results with 2 participants presenting very mild anomia associated with mild apraxia of speech show that accuracy is only marginally affected by concurrent auditory stimuli, whereas production latencies are extremely increased in the active dual-tasks relative to single tasks and to the passive dual-task.

# Discussion

On the one hand, the present study will inform on the impact of concurrent task in anomia according to the underlying impairment and the type of concurrent stimuli. On the other hand the pattern observed with aphasic participants will inform models of word production about the amount of attentional demand across word encoding processes.

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# Subcortical involvement in body and mental action verb processing: an electrophysiological registration study

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## Introduction

Electrophysiological registration of semantic processing generally involves paradigms eliciting semantic violations on recognition memory or semantic judgement tasks. The N400, LAN (left anterior negativity) and P600 may be sensitive to semantic judgement alterations on cortical level (Olichney et al., 2008). The LAN is a negative-going peak around 400 ms after word presentation and is typically elicited by morpho-syntactic violations (Coulson et al., 1998). In the context of semantic processing, P600 components have been observed in response to thematic and other semantic violations (Kuperberg et al., 2003; Kim et al., 2005).

Although semantic effects of subcortical modulation have been well described, it is unclear if semantic related local field potentials can be elicited in the main subcortical nuclei. Direct registration of language elicited EEG in the deep brain nuclei is only possible in patients recruited for deep brain stimulation as a treatment for their illness and in the short period after the operation that the electrode leads are still externalized. The current research project focusses on the electrophysiological registration of semantics (body versus mental action verbs) within the thalamus, subthalamic nucleus (STN) and the pedunculopontine nucleus (PPN) within 1 week after DBS-implantation.

## Methods

### *Patients*

The current study included 18 patients with deep brain electrodes within the STN (mean age 59 (45-71); 8 male/10 female), 2 patients with electrodes in the thalamus (mean age 64 (56-73)/1 male/1 female) and 1 male patient with PPN stimulation (50). The difference in number of patients corresponds with the

prevalence of indications for DBS in the course of two years in our centre. All patients were non-medicated and right-handed at the moment of testing.

## *Paradigms*

The event-related potential (ERP)-paradigms consisted of 30 manual action verbs (body verbs, e.g. to sew, to point) and 30 verbs without manual action connotation (mental verbs, e.g. to leave, to develop). All verbs consisted of two syllables, matched with respect to word form frequency, and imageability (Duyck, Desmet, Verbeke, & Brysbaert, 2004). The hand action and mental verbs were shown consecutively in a randomized order, with a stimulus duration of 1s and without interstimulus interval.

## *Materials*

An in-house made interface between the registration device (Neurosoft) and the STN/thalamus/PPN leads was connected to the (temporarily) bilateral externalized STN-contacts. The STN/thalamus/PPN contacts are numbered from 0 to 3, with 0 as the most distal and 3 as the most proximal contact. Data was collected using a 32 channel SynAmp (Neuroscan) amplifier. EEG analysis (ERP-waveform and source localizing) was performed in all nuclei using BrainVision Analyzer 2 (Brain Products, Munich, Germany).

# Results

The results of the current study demonstrate a grand average evoked potential (EP) between 200 and 470 ms for body action verbs within the left STN (L0-L1/L1-L2). No grand average EP can be observed for the mental action verbs or for the difference between body action and mental action verbs.

Within the left thalamus a clear grand average can be seen between 500 and 800 msec (L1-L2/L2-L3) in the action verbs and in the difference between action and non-action verbs (L1-L2/L2-L3). For the mental action verbs in the left thalamus a grand average EP can be shown between 300 and 680 ms at the same electrode contacts (L1-L2/L2-L3). Within the PPN no grand average can be observed.

# Discussion

In contrast to the PPN, the left STN and thalamus seem to be involved in semantic processing, but on a different time window. The caudal part of the left STN demonstrates semantic activity in the same time window and cerebral side as on cortical level (300-400 ms in Zhang et al, 2004). Although the thalamic electrode is positioned within the lateral motor part of the thalamus, a late but clear grand average can be seen in the left hemisphere after making difference between body action and mental action verbs.

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# Tracking speech production processes by using EEG and EMG

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## Introduction

The study aims to identify the impaired process of speech production underlying apraxia of speech. Apraxia of speech is a disorder in the motor programming of speech gestures due to brain damage. It is often diagnosed based on symptoms evident in speech, such as groping, initiation problems and distortions. Some symptoms of AoS are also observed in aphasia, which often co-occurs with apraxia of speech, as well as in dysarthria. Aphasia, apraxia of speech and dysarthria are assumed to originate from consecutive and partially overlapping processes of speech production and therefore not always easy to distinguish. The processes have been described by Levelt and colleagues (1999) and are shown in Figure 1. Lemma selection and lexeme retrieval can be impaired in aphasia. Phonological encoding can be impaired in aphasia and apraxia of speech. Phonetic encoding can be impaired in apraxia of speech and to some extent also in dysarthria. The strength and coordination of articulatory muscles are impaired in dysarthria.

The processes of lexical selection, lexical-phonological encoding as well as phonological-phonetic encoding and phonetic encoding have been distinguished in separate studies by using EEG (e.g. Costa et al., 2009; Laganaro et al., 2011, 2013; Buerki et al., 2015). However, the entire process of speech production from lexical selection until and including articulation has yet to be tracked in one study. The purpose of the project is to disentangle the processes of speech production by using electro-encephalography (EEG) and electromyography (EMG). In a first study we will test non-brain-damaged subjects to pilot the full procedure, which will be used to identify the impaired speech production process underlying apraxia of speech.

## Methods

Thirty adult native Dutch speakers without brain damage will participate in the experiment. EEG will be recorded with 64 electrodes to track the speech production processes in the brain. The articulation onset and the articulatory processes will be recorded using lip EMG with two electrodes. The verbal sound responses will be recorded. The experiment will consist of four parts: two picture naming tasks, a pseudoword reading task and a pseudoword repetition task. One naming task will be used to identify the process of lexical selection through a manipulation of the semantic relationship between successive words, which is hypothesized to increase the naming latency when more drawings that depict words of the same semantic category have to be named (Costa et al., 2009). The other naming task will be used to identify the process of lexical-phonological encoding by manipulating age of acquisition and lexeme

frequency. The tasks with pseudowords will be used to identify the process of phonological-phonetic encoding by manipulating syllable frequency.

## *Materials*

For the naming tasks, black-and-white drawings will be used. The stimuli for naming task one will depict 24 semantic categories with five drawings per category, resulting in 120 items. The words in each category will have comparable lemma frequencies. The 140 depicted words for the other naming task will be matched for age of acquisition, which ranges from preschool to early elementary school, and lexeme frequency. The 140 pseudowords for the reading task and the repetition task will each consist of two frequency matched meaningless syllables that exist in Dutch.

## *Analyses*

An electrode and a waveform sampling point analysis will be performed with the EEG data to identify the processes of word production from the moment of stimulus presentation until the onset of the articulation. The data will be analyzed in stimulus locked and response locked time windows.

- The time windows which show an effect of the semantic relationship between words within the semantic categories as well as an effect of lemma frequency between the semantic categories in the data from the first naming task will be related to lexical selection.
- Lexical-phonological encoding will be identified in time windows with an effect of age of acquisition and lexeme frequency in the data from the second naming task.
- An effect of syllable frequency will index the time windows related to phonological-phonetic encoding in the data from the pseudoword repetition and reading tasks.

Apart from that, T(opographic)-ANOVA's will be performed to identify topographic differences between the conditions targeting specific speech production processes.

The EMG data will be analyzed from the moment of activation of the muscles until the end of the articulation. It will be tested whether or not more effortful lexical selection, lexical-phonological encoding and phonological-phonetic encoding processes show an effect in the timing of the articulation. Audio recordings will be used to check for errors in the responses of the participant.

# Results

Data collection is in progress.

# Discussion

After the results of the first study have shown that the speech production processes can be disentangled in the non-brain-damaged population using the methods described in this abstract, the same methods will be applied to disentangle the speech production processes in individuals with (1) apraxia of speech

and aphasia, (2) pure aphasia and (3) dysarthria. If apraxia of speech can be distinguished from aphasia and dysarthria based on the EEG and EMG we can isolate the impaired speech production process underlying apraxia of speech. It is then possible to develop an EEG protocol for the diagnosis of apraxia of speech in clinical settings.

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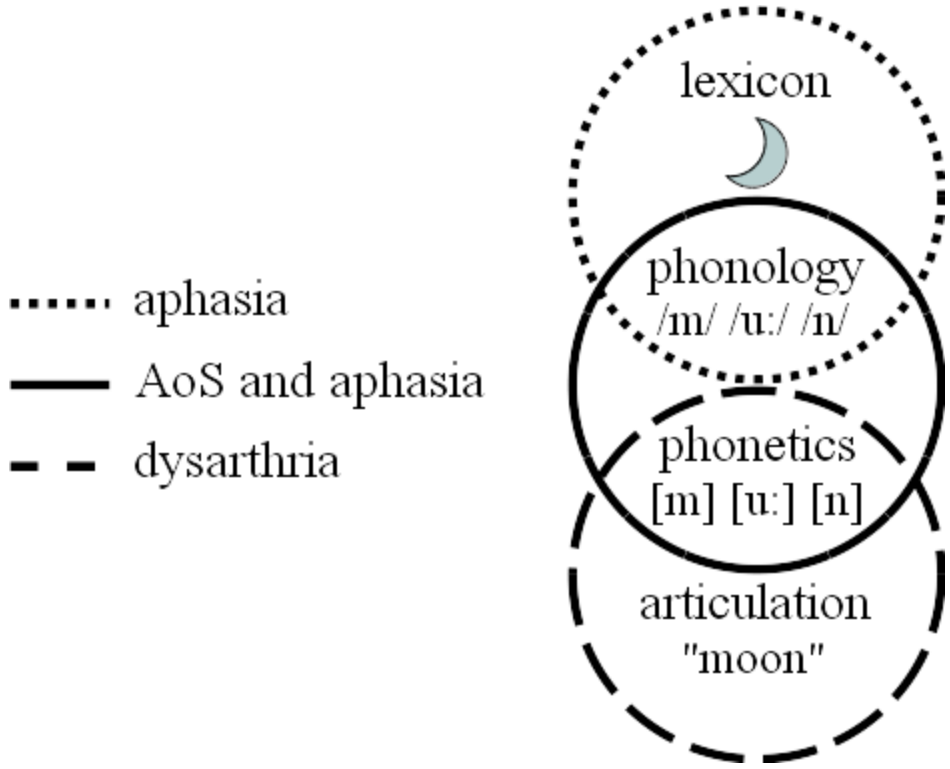


Figure 1: the circles show which processes could be impaired in aphasia, apraxia of speech and dysarthria and how the disorders overlap.

# A new tool for aphasia evaluation: The Core Assessment of LAnguage Processing (CALAP)

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## Introduction

Aphasia is a public health concern: it causes depression, social withdrawal and long periods of unemployment. In order to improve clinical care of aphasic patients, brief and easy-to-use batteries of language assessment are required. Standard batteries that exist in French, eg BDAE[1] have several limits: (1) they are time-consuming, (2) they can only be administered by speech therapists, (3) they provide syndrome-based interpretation, which are not suited for rehabilitation[2]. As a consequence, the rehabilitation of aphasic patients is often delayed and not efficient.

Our objective was to develop a short battery (less than 15 min), based on a cognitive model of speech processing[3-6], easy to administrate (no need of a speech therapist), and whose outcome can directly be used to guide speech rehabilitation[7-9]. To this aim, we developed and validated the Core Assessment of LAnguage Processing (CALAP), a new tool for assessing language abilities in French speaking patients.

## Methods

### *CALAP rationale*

The development of CALAP is based on a cognitive model of language processing. It is composed of a screening phase whose result is used to decide whether the participant needs to carry on with a more detailed evaluation. We focused on the evaluation of the oral language, assessing comprehension, production and language repetition. Within each modality, phonological, lexical, morphological and syntactic processes are specifically assessed (if possible).

### *CALAP Validation*

189 participants (92 healthy controls, 30 brain-damaged patients without aphasia and 67 brain-damaged patients with aphasia) were tested with the CALAP. In order to validate the CALAP, we used the BDAE as the gold standard; brain-damaged patients were considered as aphasic or non aphasic on the basis of their BDAE results. Two experimented psychologists rated a subsample of 29 participants, and each of these participants was assessed tested again a week after. The CALAP was validated on the basis of (1)

criterion validity, (2) external validity, (3) concurrent validty, (4) internal validity, (5) inter-rater agreement and (6) test-retest consistency.

# Results

The mean time to complete the screening is 3 min 40 sec and to complete the detailed evaluation is 11 min 15 sec.

Screening criterion validity: A total screening score (0–24 points) was computed as the sum of all participants' responses to screening items. Total mean (SD) scores for each group of participants are as follows: controls, 23.3 (1.2); non-aphasic patients, 22.5 (1.9); aphasic patients, 14.9 (5.0). There is a significant difference between the three groups (Kruskal-Wallis ANOVA, $p < 0.001$). Aphasic patients are found to have on average a lower score compared to non-aphasic or controls patients (Wilcoxon rank sum test, $p < 0.001$).

Detailed evaluation criterion validity: A total score was separately computed for comprehension (0-48 points), production (0-16 points), and repetition (0–24 points). Total mean (SD) scores for each group of participants are respectively: 47.7 (0.8), 15.5 (1.2) and 23.4 (1.0) for controls; 46.5 (2.1), 14.5 (1.5), 22.3 (2.5) for non-aphasic patients; and 41.7 (7.7), 9.9 (4.7), 13.4 (8.6) for aphasic patients. There is a significant difference between the three groups (Kruskal-Wallis ANOVA, $p < 0.001$ for comprehension, production and repetition). Aphasic patients are found to have on average a lower score compared to non-aphasic or controls patients (Wilcoxon rank sum test, $p < 0.001$ for comprehension, production and repetition).

The BDAE was used as the gold standard for external validation of the screening. The Receiver operating characteristic (ROC) analysis was computed on 30 non-aphasic patients and 67 aphasic patients on their screening score. The optimal cut-off for the sensitivity (true-positive rate, ability to correctly identify aphasic patients) and specificity (true-negative rate, ability to correctly identify non-aphasic patients) is the score of 21 (sensitivity=.93, 95% CI [81.8;100.0] and specificity=.85, 95% CI [73.1;96.6]). The area under the curve was estimated at 0.964 (95% CI, [0.942;0.987]). The PPV (Positive Predictive Value) that answers the question « How likely is that this patient is aphasic given that his score is ≤21» is .65. The NPV (Negative Predictive Value) that answers the question « How likely is that this patient is not aphasic given that his score is >21» is .98.

Concurrent validity against the BDAE shows a good correlation of CALAP scores (detailed evaluation) with BDAE scores (Pearson r for comprehension r=0.623; production r=0.835; repetition r=0.733; $p<0.001$ for all).

Internal validity shows that screening scores and detailed evaluation scores are highly correlated (Pearson r for comprehension r=0.555; production r=0.778; repetition r= 0.933; $p<0.001$ for all)

Inter-rater agreement was assessed using intraclass correlation. Inter-rater reliability is very good (screening, 0.9; comprehension, 0.845; repetition, 0.99, production, 0.95). Test-retest consistency was

assessed using intraclass correlation (screening, 0.96; comprehension, 0.58; repetition, 0.98, production, 0.97).

# Discussion

The CALAP is a validated 2-step battery with a screening and a detailed evaluation phase. It is well correlated to the gold standard but much shorter, less than 15 min, making it suitable for testing patients with fatigability and concentration deficits. It is easy to administrate with high constraints on the possible patient responses, such that it can be used, scored and interpreted by people without clinical experience of aphasia. It shows good internal validity and reliability (rater and retest effect). It specifies the impaired components of language processing and can orientate patients' clinical follow-up and guide rehabilitation.

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# Sentence Production in Standard Indonesian Broca's Aphasia

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# Introduction

Individuals with agrammatic aphasia experience deficits in producing certain syntactic structures (Menn, Obler, & Goodglass, 1990). Several studies have reported that semantically reversible sentences are more difficult to produce than irreversible ones (Saffran, Schwartz, & Marin, 1980). The Derived Order Problem Hypothesis (DOP-H; Bastiaanse & Van Zonneveld, 2005; 2006) addresses these deficits by postulating that for agrammatic individuals the derived word order (e.g., the passive in English) is more difficult than the base word order (e.g. the active in English) in both production and comprehension. The DOP-H assumes that languages have a default 'base word order' where constituents are positioned in the order that occurs naturally or most commonly. Other word orders are 'derived' by particular linguistic operations and are predicted to be more difficult for individuals with agrammatic aphasia. While empirical support for the DOP-H has been shown across languages (for a review, see: Abuom, Shah, & Bastiaanse, 2013), recent findings (Jap, Martinez-Ferreiro, Bastiaanse, 2016) in Standard Indonesian (SI) show that in comprehension, other factors such as the frequency of occurrence of structures and pragmatic constraints affect the performance of aphasic individuals with a grammatical deficit. For the current study, we tested whether this exception to the DOP-H can also be observed across modalities, using a sentence production paradigm.

In comprehension, the passive structure in SI was observed to be unimpaired (Postman, 2004; Jap et al., 2016). Also, in SI agrammatic spontaneous speech (Anjarningsih, Haryadi-Soebadi, Gofir, & Bastiaanse, 2012) passives are produced with a frequency that is proportional to that of non-brain-damaged speakers. The main difference between passives in SI and other languages is the high frequency in SI (Sneddon, 1996). The present study aims to examine the ability of SI agrammatic speakers to produce passive sentences in SI. We introduce two variables, that is, word order and reversibility, to investigate the influence of the word order factor in conjunction with reversibility distinctions in aphasic sentence production. The DOP-H predicts that passive sentences are more difficult to produce than active sentences, but we expect that this is overruled by the fact that passives are highly frequent in SI.

# Methods

## *Participants*

Initially sixteen individuals with aphasia (IWAs; mean age: 69; range: 55-92; 9 males; mean months post-onset: 64.4) and fifteen non-brain-damaged Indonesian speakers (NBDs; mean age: 71; range:53-82; 9

males) participated in this study. Four IWAs were excluded because they do not exhibit agrammatic symptoms. IWAs with the diagnosis Broca's aphasia or transcortical motor aphasia were included when they spoke agrammatically. IWAs originated from 6 nursing homes in Central Java. A screening test was held prior to testing. IWAs with more than 12 errors on the Token Test were tested with the SI aphasia battery TADIR (Dharmaperwira-Prins, 1996) to confirm aphasic symptoms and classify aphasia type.

## *Materials*

Sentence production was tested with a primed elicitation task. The task contained 40 semantically reversible sentences and 20 non-reversible sentences distributed over 4 experimental conditions (examples below): 20 reversible actives (1), 20 reversible passives (2), 10 non-reversible actives (3), and 10 non-reversible passive (4). Each item was presented as a set of written verb and two pictures: one prime and one target picture. The experimenter named the people and animals in the pictures and verbally produced a sentence using the printed verb to describe the prime picture. Then, the participant is asked to produce a sentence of parallel structure to describe the second picture.

| | | | |
|---|---|---|---|
| 1) | Sapi | **me**nendang | kuda. |
| | Cow | **ACT**-kick | horse. |
| | The cow | kicks | the horse. |
| 2) | Kuda | **di**tendang | sapi. |
| | Horse | **PASS**-kick | cow. |
| | The horse | is kicked by | the cow. |
| 3) | Wanita | **me**nulis | surat. |
| | woman | **ACT**-write | letter. |
| | The woman | writes | the letter. |
| 4) | Surat | **di**tulis | wanita. |
| | Letter | **PASS**-write | woman. |
| | The letter is | written by the | woman. |

# Results

The group of 15 NBDs performed close to ceiling level (mean proportion correct = 0.96, range=54-60 out of 60) and scored significantly higher than the IWAs ($t(25)=-9.297$, $p=.000$). The scores for agrammatic individuals are given in Table 1.

Table 1. Sentence production results for aphasic speakers (maximum 20 per reversible condition, 10 per non-reversible condition; 60 in total per IWA)

| | type | total | active reversible | passive reversible | active non-reversible | passive non-reversible |
|---|---|---|---|---|---|---|
| 1 | Broca | 47 | 19 | 16 | 10 | 5 |
| 2 | TCM | 50 | 17 | 14 | 9 | 10 |
| 3 | Broca | 52 | 18 | 17 | 8 | 9 |
| 4 | Broca | 48 | 15 | 17 | 10 | 6 |
| 5 | TCM | 43 | 17 | 9 | 8 | 9 |
| 6 | Broca | 50 | 19 | 15 | 9 | 7 |
| 7 | Broca | 46 | 17 | 15 | 6 | 8 |
| 8 | Broca | 41 | 15 | 13 | 5 | 8 |
| 9 | Broca | 40 | 19 | 4 | 10 | 7 |
| 10 | TCM | 38 | 13 | 11 | 8 | 6 |
| 11 | Broca | 45 | 14 | 15 | 8 | 8 |
| 12 | Broca | 40 | 17 | 11 | 7 | 5 |
| | **Max** | **60** | 20 | 20 | 10 | 10 |
| | **Mean** | **45** | 17.33 | 13.33 | 8.33 | 7.66 |
| | **SD** | **4.39** | 1.92 | 3.63 | 1.51 | 1.54 |
| | **%** | **0.77** | 0.83 | 0.76 | 0.86 | 0.66 |

*total represents raw score of correct responses; while the adjacent columns show raw scores in the respective categories. % shows the average percentage of correct responses

Note: TCM= transcortical motor aphasia

A generalized linear mixed-effects model by maximum likelihood with reversibility and word order as fixed effects is fitted. Two random effects, namely, subject and trial number is also included in the model. There were no main effects of reversibility (β=.02, SE=.25, p=.92) and word order (β=-.48, SE=.32, p=.12). Additionally, no interaction between reversibility and word order was observed (β=-.41, SE=.38, p=.29).

# Discussion

The hypothesis was that frequency affects production to the extent that it overrules the effect of word order. Indeed, the model did not reflect the effect of word order nor reversibility. The current results are consistent with those of Anjarningsih et al. (2012) who found that the passive is relatively well spared in SI IWA production. This would also confirm the cross-modal effect of syntactic frequency as was shown in comprehension (Jap et al., 2016).

However, the group of IWA is not large, and the results should be interpreted cautiously. Inspection of Table 1 shows that there are, in fact, a select few that have severe impairment on the production of the

reversible passive (participant 5 & 9). Hence, though the main effects of word order and reversibility were not found at the group level, the individual data shows that two individuals are impaired in the production of reversible passive sentences in SI.

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# From foreign accent to neologistic jargon in a patient with psychogenic FAS

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## Introduction

Foreign Accent Syndrome (FAS) occurs under the form of four etiologically different subtypes. A neurogenic, developmental, psychogenic and mixed subtype have been defined by Verhoeven and Mariën (2010). In recent years, psychogenic FAS has been increasingly documented. We present the case of a 28-year-old, monolingual, native Dutch-speaking woman from the Netherlands who developed a foreign accent (Flemish/German) in the third trimester of her pregnancy after a fall down the staircase. Apart from FAS a neurological work-up did not disclose any abnormalities. The accent was associated with language mixing and switching: fluent, non-aphasic speech was interspersed with German(-like) words and structures. When stress, fatigue or emotional load increased, speech evolved to a neologistic jargon. Accounts of her personal life revealed traumatic events may have been of play in the accent development as part of a psychological disorder. To test this, a series of psychodiagnostic tests were performed. For the first time, a case of FAS in combination with neologistic jargon is described.

## Methods

The patient underwent neuropsychological, neurolinguistic and psychodiagnostic tests within the framework of traditional hospital work-up for suspected psychogenic foreign accent syndrome. Psychodiagnostic testing consisted of a structured interview and standardized psychodiagnostic tests. Speech samples delivered by the patient's husband (recorded at home) were acoustically and perceptually analyzed (see Table 1, part B).

## Results

The patient underwent a series of neuropsychological tests on two occasions disclosing selective deficits of recent memory [2014: WMS-R index = 70 (-2 SD) and 2015: 76 (-1.6 SD); RBANS index = 56 (-2.9 SD)].

Other scores were within the accepted range. Apart for the BNT (2014: 41/60;2015: 44/60) neurolinguistic investigations were normal.

Her overall personality profile (MMPI, DSQ, DEQ) revealed a sensitive, people-pleasing, analytic personality. The code-types of the patient were associated with transient past psychotic symptoms. Her mother's death (childhood trauma) and the complicated relationship with her stepmother and biological father predominated the clinical interview. Importantly, during the first interviews, her accent was quite absent, only slightly noticeable when technical or prosaic contents were discussed. By moving the subject of the conversation, and the amount of individuals present during the conversation - thus varying the emotional pressure, cognitive load and fatigue – the examiner could induce quantitative distortion in her accent quite experimentally until a neologistic jargon speech arose.

Apart from a marked tendency towards monophthongization there were no major violations against Dutch phonetics in example sample 2 on the phonetic level. In sample 3 and 4 changes consisted of language substitutions and/or language mixing. Especially phonetic, lexical, and morphological substitutions were found (see Table 1). Occasionally, neologisms intruded normal, fluent speech.

Acoustic analysis was carried out for all samples except for the first because no syllables were discernable in the neologistic jargon productions. For the second sample speech rate (SR; including silent and filled pauses) amounted to 3.51 syll/sec. and articulation rate (AR; excluding silent pauses) amounted to 4.87 syll/sec. For the third sample, SR amounted to a mere 1.98 syll/sec. whilst AR was 3.26 syll/sec. In the fourth sample SR was slower: 1.58 syll/sec. and AR was 2.98 syll/sec. When language substitution occurred, rates dropped significantly. The Pairwise Variability Index (PVI) (Grabe and Low, 2002) was calculated for each of the samples. The normalized vocalic PVI (*nvPVI*) value for Dutch (a stress-timed language) is situated around 65.5. The nvPVI for the second sample amounted to 53.2, which is too low for Dutch, and is closer to the PVI index for German (59.7). For sample 3 nvPVI amounted to 55.8 and for sample 4, nvPVI was 50. In summary, rhythm did not correspond to values expected for Dutch.

# Discussion and conclusion

A patient with psychogenic FAS is presented who demonstrated language mixing and switching behavior in the absence of neurological damage. Psychodiagnostic investigations indicated 1) transient psychotic events and 2) traumatic childhood experience of parent-loss. Psychotic experiences and a change of accent occurred directly after a fall while the patient was pregnant. The accent - primarily characterized by suprasegmental changes - strongly fluctuated. Whenever stressed or fatigued the patient's accent became Flemish/German-like, after which it could evolve to German-like speech with clear lexical borrowings from Dutch, and neologistic jargon. The patient was aware she spoke differently[1], but could not control her speech.

In neurogenic FAS cases only morphological mixing behavior has been reported in a polyglot aphasic patient described Kwon & Kim (2006). For two non-aphasic patients with "mixed FAS", language and code switching was demonstrated. In "mixed FAS" the patient acquires FAS on neurological grounds, but further develops the accent in order to make it fit with a newly developed identity (Verhoeven and Mariën,2010). Their substitutions were less far-going than for current patient: Laures-Gore et al. (2006)'s patient substituted *yes* by *si* and Ryalls and Whiteside (2006)'s patient occasionally substituted American by British expressions[2]. Their linguistic behavior was explained as an attempt to make the language fit with the associated accent.

Reeves and Norton (2001)'s schizophrenic patient substituted American by British expressions when in a psychotic state. Polak et al. (2013)'s patients' register changed in relation to OCD. Current patient's language switching and mixing behavior approximates the linguistic behavior of the conversion patient reported by Verhoeven et al. (2005). However, never has there been a report of FAS evolving to jargon. Neologistic jargon is typically associated with (1) psychosis (e.g. in schizophrenia) or (2) a (fluent) aphasia. However, if the latter were the case, we would expect neurological damage and (usually) deteriorated comprehension skills[3]. Moreover, the (inducible) fluctuations between grammatical, comprehensible, fluent speech and episodes of jargon speech are inexplicable in the context of neurological disorder. We hence hypothesize that this patient developed an accent change, language mixing and switching behavior based on psychiatric affectation.

Notes

1 See metalinguistic comments in sample 4

2 We are aware that the term "lexical borrowings" could also be employed in this context. Muysken p. (1995, 189) defines lexical borrowings as "incorporation of lexical elements from one language in the lexicon of another language".

3 Some exceptions have been noted e.g. Kinsbourne and Warrington (1963)

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**Table 1.** PART A: Overview of the mistakes affecting the speech of the patient in three samples; PART B: Transcription of the samples with an indication of the type of mistake/change

| *PART A: mistakes* | | |
|---|---|---|
| SAMPLE 2 | *Occurrence (raw number)* | *Percentage (vis-à-vis total number of words)* |
| Phonetic substitution | - | - |
| Morphological substitution | 1 | 1% |
| Lexical substitution/lexical borrowing | - | - |
| Neologism | - | - |
| Addition | - | - |
| Omission | - | - |
| Semantic jargon | (last 2 utterances) | 15% of utterances |
| SAMPLE 3 | *Occurrence (raw number)* | *Percentage (vis-à-vis total number of words)* |
| Phonetic substitution | 2 | 5% |
| Morphological substitution | 3 | 7% |
| Lexical substitution/lexical borrowing | 10 | 23% |
| Neologism | 3 | 7% |
| Addition | - | - |
| Omission | - | - |
| Semantic jargon | - | - |
| SAMPLE 4 | *Occurrence (raw number)* | *Percentage (vis-à-vis total number of words)* |
| Phonetic substitution | 3 | 3% |
| Morphological substitution | 12 | 12% |
| Lexical substitution/lexical borrowing | 12 | 12% |
| Neologism | - | - |

| | | |
|---|---|---|
| Addition | 5 | 5% |
| Omission | 4 | 4% |
| Semantic jargon | - | - |

*PART B:* Samples

Below a transcription is provided of three samples: 2, 3 and 4. The first sample consisted of a phonemic jargon which could not readily be described. Mistakes were underlined in order to distinguish between: phonetic substitution, morphological substitution, lexical substitution / lexical borrowing, neologism, *syntax*, addition, omission, semantic jargon

SAMPLE 1 – JARGON

SAMPLE 2 – ACCENTED SPEECH

Na de zomervakantie kun je daar eens aan gaan denken
ja, dus ik dacht nah als we terug zijn van vakantie ok, dan kan ik dan kan ik daaraan gaan denken
dan kunnen de rubberen ballonekes de deur uit ge kent het wel
ok, in ieders geval ik kan dat tegen jou gewoon vertellen want da maakt niks uit
ik hoef daar geen geheim van te maken nee, want zegt mijnheer ja we hebben nog totaal geen zekerheid
ge weet nie wat ge voor geld gaat krijgen van 't rijk.
nou, ok, daar zit ook wat in, maar ja ik zeg tegen hum ik was boos want ik zeg gij ziet altijd beren en wilde gij da wel
want ja is aan de andere kant ook de vraag hé kan ik voor twee kinderen zorgen
en mijnheer zit 'r dan met drie opgescheept
met drie halve zolen
*dat is ø probleem.*
Maar zegt mijnheer, als wij wachten augustus, september oktober november december net wanneer gebeurt,
ja, maar na augustus had ik niets beter, mocht het dan snel zo zijn.

SAMPLE 3 – GERMAN-LIKE SPEECH

Sie haben die mosen geputzt, die mosen, die mosen da.
Und die table, und die televisione, c'est le kanse die kaste, und andere alles kaste, alles toilette, ja, alles kausen, want ich müssen diesen und alles mit den schurmacher schunmachen,
ich weiß niet was.

SAMPLE 4 – GERMAN-LIKE SPEECH

Ich haben die frau gesag dass ich nach dokter muss.
Ja das is nodig das ich nach dokter gehen, aber ich könnte das nicht gut auf die exercises
Sie finden das gut
das weißen ich nicht aber dass moss ich moss ja ich moss lernen dass ich nicht gut *sprechen nicht normale kann sprechen*
aber sie finden dass sehr gut wanneer menschen mich verstehen könnten.
Ja, das is gut.
Want als ich deutsch vlaams sprechen ... das machen nichts aus.
Aber das müssen keine deutsch sin. no no no.
Ja. neunzehn, dann musst du auch vroeg zu hausen sein von die arbeit.

# Numerical abilities of Hungarian aphasic patients

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## Introduction

There are competitive conceptions of the relation between linguistic and numerical abilities (Semenza, 2008; Roselli and Ardila, 1997, Denes, 2011). Recently numerous study reported that numerical abilities are connected with language processing (De Luccia and Ortiz, 2014; Messina, Gianfranco and Basso 2009), at the same time some numerical mechanism are independent from language (Rath et al. 2015; Semenza, 2008). There are partial overlaps between language and numerical abilities (Baldo and Dronkers, 2007). The aim of this paper is to get better insight into numerical skills of Hungarian aphasic patients. According to previous studies we focus on dissociation between numerical and language abilities.

## Methods

### *Patients*

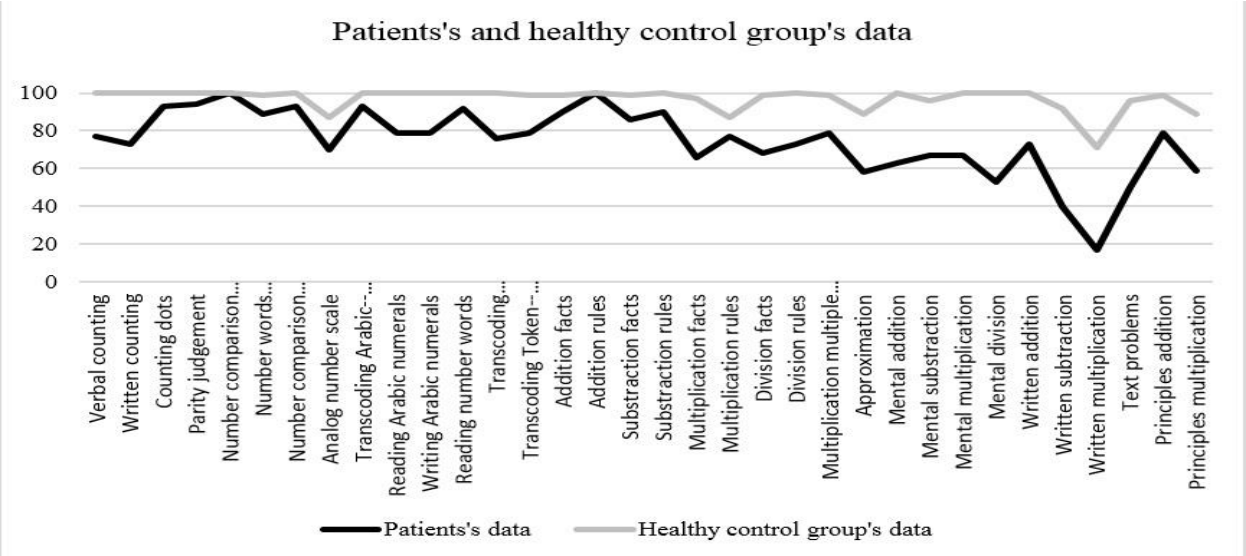
We examined 10 patients who were suffering from aphasia following stroke. There were 5 female and 5 male participants in the study at the Center for Neurorehabilitation of the Department of Neurology of the University of Szeged. The average age of the patients was 48,9 years (range: 23-68 years), the average years of education was 13 years (range: 11 to 15 years). There were 1 Broca aphasic, two transcortical-sensory aphasic and seven anomic aphasic patients in the examined group. Depending on the severity of aphasia 5 mildly and 5 moderately damaged aphasic patients were included. Data of our patients were compared with a healthy control group.

### *Tasks*

Patients were tested by linguistic and numerical tests: Hungarian version of Western Aphasia Battery (Sagi, 1991), Boston Naming Test (Goodglass et al, 2001) and Token Test (Sagi, 1983), Hungarian version (Igacs et al, 2007) of Number Processing and Calculation (NPC, Delazer et al. 2003) were used. NPC contains four group of tasks: counting, comprehension of numbers, numerical transcoding and calculation. This battery includes a total of 35 tasks which assess all kinds of numerical processing in all kinds of modality.

## Results

Data were related to 3 subcategories: standard of NPC (Delazer et al. 2003), Hungarian healthy control, 100% test points. Patients with aphasia showed worse performance during the tasks correlated to healthy groups. They had the worst results in calculation (75%) and numerical transcoding tasks (81%). Multiplication (69%) and division (72%) seemed to be the most difficult operations while they could solve the addition exercises almost correctly (90%). They also had difficulties in solving text problems (58%). Those tasks which include transcoding operations and verbal components seemed to be much more difficult than the others and written calculation (52%) is much more difficult for aphasic patients than mental calculation (73%). We also analyzed arithmetical facts, rules and principles. We found that our patients had the best performance in using arithmetical rules (93%). Comparing mildly and moderately damaged aphasic patients' performance we found that mildly damaged aphasic patients had significantly better performance (96%) than severe ones (64% ) in all kind of tasks.



# Discussion

The aim of our study was to give a first description of Hungarian aphasic patients' performance of numerical tasks. We examined the correlation between language disorder's rate and numerical abilities. Our findings have shown that aphasic patients had difficulties with numerical tasks. It can be seen that the range of numerical abilities are influenced by linguistic disorders. Mildly damaged aphasic patients had better performance in numerical tasks than severely damaged aphasic patients. In order to make a deeper reveal further researches are needed.

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# Frequency affects processing of verbs and argument structure in acquired aphasia: results from a pilot investigation

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## Introduction

In English, verbs do not occur in isolation. The combination of syntactic phrases that occur around a verb is referred to as argument structure. For example, the ditransitive refers to a sentence that contains a verb followed by two objects, as in *we sent them a letter*. In the linguistic framework Construction Grammar (Goldberg, 1995), argument structures such as the ditransitive are recognised as meaningful linguistic units independent of the verbs they contain. These units are called argument structure constructions, and they are associated with event-level semantics; for example, the ditransitive construction refers to an event in which the transfer of an object takes place. In the previous example, the letter is transferred from the subject *we* to the recipient *them*.

Individuals with acquired aphasia may have impairments at the level of the verb or the argument structure construction. Some speakers with aphasia have difficulty producing lexical verbs but retain the ability to produce some argument structures (Berndt et al., 1997). Conversely, some speakers with aphasia have intact single word processing but impaired production of argument structure (Whitworth et al., 2015). Frequency effects can also influence sentence processing in aphasia. Individuals with aphasia have shown more difficulty responding to words with low lexical frequency in written sentence comprehension (DeDe, 2012) and sentence production (Goral et al., 2010).

This aim of this study was to explore the relationship between verbs and argument structure constructions in adults with acquired aphasia. Specifically, we asked whether the frequency of a lexical verb or the frequency of the occurrence of a verb in an argument structure construction had an effect on participants' responses to verbs, given particular argument structure constructions. Such a finding would suggest that individuals with aphasia remain sensitive to usage-based properties of language following brain damage.

## Methods

Three participants with post-stroke aphasia and three age- and gender-matched control participants without aphasia took part in this study. Participants with aphasia passed three screening tasks before taking part in the experiment, including sentence reading, function word processing and grammaticality judgement.

### *Materials*

Several argument structure constructions were included in the experimental task. Each construction was paired with a set of four verbs that differed in lexical and construction frequency. Lexical frequency

referred to the frequency of occurrence of verbs as single words in British English, in instances per million (Leech et al., 2001). Construction frequency referred to the number of times speakers without aphasia produced the verb in response to the construction on a verbal fluency task (Anderson et al., forthcoming).

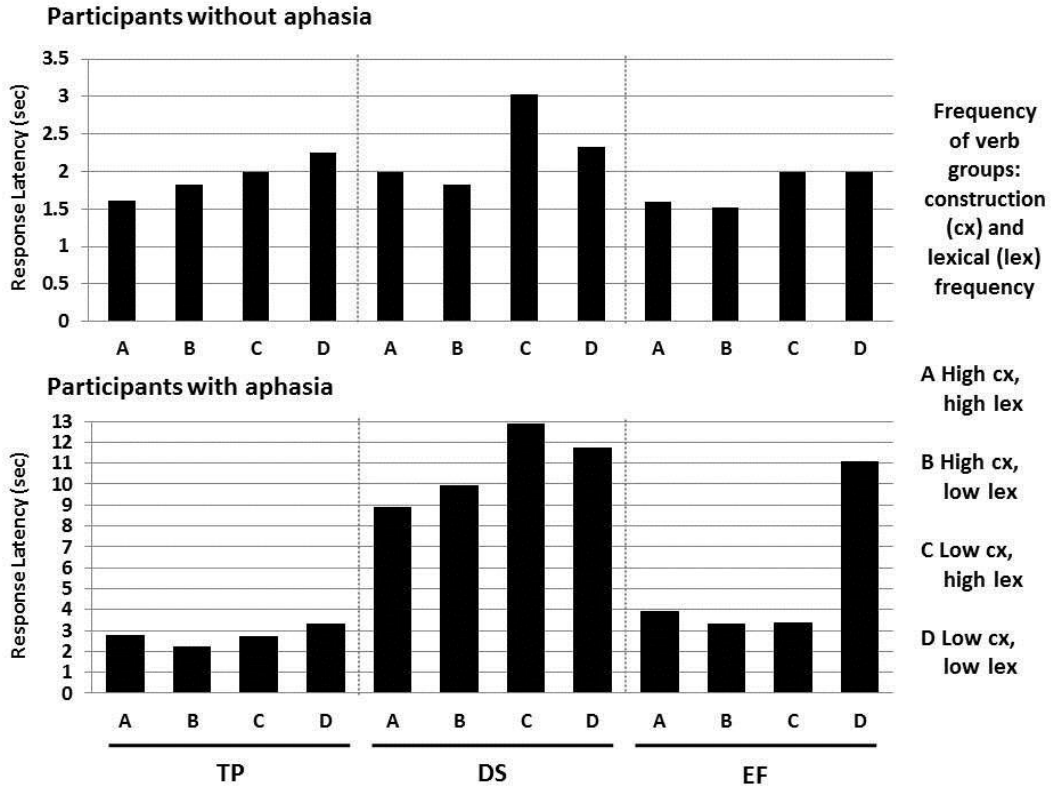
Each set of four verbs contained a pair of verbs with high and low lexical frequency. In each pair, one member had high construction frequency and one member had low construction frequency. In this way, lexical and construction frequency were in inorthogonal variation in each set of verbs. Verbs that differed in one frequency measure were controlled on the other; for example, verbs that differed in construction frequency were matched for lexical frequency.

### *Grammaticality judgement task*

Participants were asked to determine whether verbs could be used in argument structure constructions on a grammaticality judgement task that contained an equal number of grammatical and ungrammatical items. Argument structure constructions were presented on a computer screen as written sentences that were composed entirely of pronouns and function words, so no lexical semantic information was available from the sentence stimulus. A blank space stood in place of the verb. For example, the ditransitive construction was presented as *we* _____ *them something*. After reading the sentence silently, participants pressed a button to reveal a verb presented as a single word, such as *give*. Participants responded to whether the verb could be used in the sentence by pressing a green or red button for 'yes' or 'no'. The dependent measure was the latency of this button press. The sentence remained on screen whilst participants produced their responses, so no recall was required. The sentence of the next trial was presented 500 milliseconds after participants responded to the verb.

## Results

Results from the three participants with aphasia are shown below, with results from the three control participants without aphasia. Each bar represents a participant's median response time to verbs with the same attributes of lexical and construction frequency. These verbs all elicited a 'yes' judgement on the grammaticality judgement task, i.e. they could all be used grammatically in the argument structure construction. Participants' inaccurate responses were excluded from the analyses.




Results from participants with aphasia are shown in the lower pane as a case series. Results from each control participant are shown directly above results from each participant with aphasia in the upper pane. The Y-axes shows participants' response latency in seconds; note that the scales differ for participants with and without aphasia, as participants with aphasia generally responded more slowly than participants without aphasia.

Participants without aphasia all responded more quickly to verbs with high compared to low construction frequency, for verbs with high and low lexical frequency. Participants with aphasia demonstrated an effect of construction frequency in some instances. DS responded more quickly to verbs with high construction frequency, for verbs with high and low lexical frequency. TP and EF responded more quickly to verbs with high compared to low construction frequency, for verbs with low lexical frequency.

# Discussion

This research has provided some initial evidence that adults with acquired aphasia may be sensitive to usage-based factors of frequency when processing verbs and argument structure constructions. Such a finding supports the applicability of probabilistic models of sentence processing to language in aphasia, which hold that language experience influences language processing (Gahl & Menn, 2016). Clinical implications of such a finding include the need to consider the strength of the relationship between a verb and its sentence context in the assessment and intervention of sentence-level difficulties in

aphasia, similar to the way in which lexical frequency effects are currently recognised in the assessment of single words (e.g. Druks & Masterson, 2000).

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# Less is more-Effects of semantic neighbourhood on naming in semantic dementia (svPPA)

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## Introduction

When we want to say a word (e.g., 'bench'), its meaning is activated which also results in automatic activation of words that share this meaning (e.g., chair, sofa) – semantic neighbours (SNs). Once lexical representations are activated, a mechanism is needed that selects the target from the cohort of co-activated SNs. Some language theories (e.g., Dell, 1986) propose non-competitive lexical selection with the most highly activated representation being selected. In those theories, target words are proposed to benefit from SNs through feedback via their shared meaning. An alternative mechanism is lexical selection by competition (e.g., Levelt et al., 1999), whereby a target has to compete for selection with all of its SNs. The more SNs there are and/or the higher their activation (e.g., for semantically very similar or close SNs) the more difficult it becomes to select the target. Although semantic neighbourhood should be a major predictor of successful lexical selection in both theories, its predicted effects are opposite with facilitation for non-competitive versus interference for competitive selection. Furthermore, it remains unclear which SN-variables are critical for lexical selection. For example, are words that share more semantic features and thus are more similar to the target word harder to select (semantic neighbourhood *distance*-SNdistance) and/or are the harder words those with more SNs – that have greater semantic neighbourhood *density* (SNdensity).

To date, only a few studies have investigated SN-effects on naming in aphasia with results being inconsistent across studies. For example, Best et al. (2006) found that items with close SNs (living things) were named more accurately compared to items with less close (distant) SNs (non-living things). In contrast, Mirman (2011) found a SNdistance effect restricted to semantic errors with more semantic errors for words that have many close SNs compared to words with few close SNs.

In this study, we used SNdensity and SNdistance to test theories of lexical selection in naming with people who suffer from the semantic variant of primary progressive aphasia (svPPA). If lexical selection is competitive, we would expect that naming becomes more difficult leading to less accurate responses and/or the production of more semantic errors for target words with (a) many SNs, and/or (b) many

close SNs compared to target words with (c) few SNs and/or (d) few close SNs. Conversely, if lexical selection is non-competitive, we would expect that naming of a target word becomes easier resulting in more accurate responses and/or the production of less semantic errors in condition (a) and/or condition (b) compared to condition (c) and/or (d).

# Methods

## *Participants*

At present 7 participants with svPPA have completed this study, further data will be collected by the time of the conference.

## *Semantic Neighbourhood Materials & Task*

Stimuli consisted of two picture sets, each comprising two subsets that were manipulated for one of the SN-variables, but matched on the other SN-variable and on visual complexity, imageability, familiarity, age of acquisition, frequency and length. Set A comprised 56 nouns, half with many SNs and half with few SNs using Borman et al.'s (2008) SNdensity measure. Set B consisted of 44 nouns half with many near SNs and half with few near SNs using McRae et al.'s (2005) SNdistance norms. In order to investigate SN-effects, spoken picture naming accuracy and the number of semantic errors were compared across the different SN-subsets.

# Results

*SNdensity*

No significant effects of SNdensity were found for naming accuracy ($t(6)=-.457, p=.664$) or semantic errors ($t(6)=-1.369, p=.220$).

*SNdistance*

A significant effect of SNdistance was found for naming accuracy ($t(6)=-3.361, p=.015$), but not for semantic errors ($t(6)=-.283, p=.283$). Words with many close SN were named less accurately than words with few close SN.

# Discussion

In line with our predictions for lexical selection by competition, there was an effect of SNdistance on naming accuracy whereby words with many close SN were named less accurately than words with few close SN. According to a competition account, close SN are more highly co-activated than distant SN due to sharing more meaning (e.g., in form of semantic features) with the target. Lexical selection becomes more difficult for target words with many close SN compared to targets with few close SN due to having to overcome greater interference in the former than the latter case. The fact that a SN-effect was only found for SNdistance, but not for SNdensity indicates that the number of close SN is an important

predictor of successful naming as it might determine the activation levels of a target's SNs and thus predict how competitive they are during lexical selection.

Data collection is continuing and in addition to accuracy and semantic errors, effects of SN-variables on the production of different semantic error subtypes will be analysed and discussed for the group as a whole, for subgroups according to the severity of their naming impairment and for single subjects.

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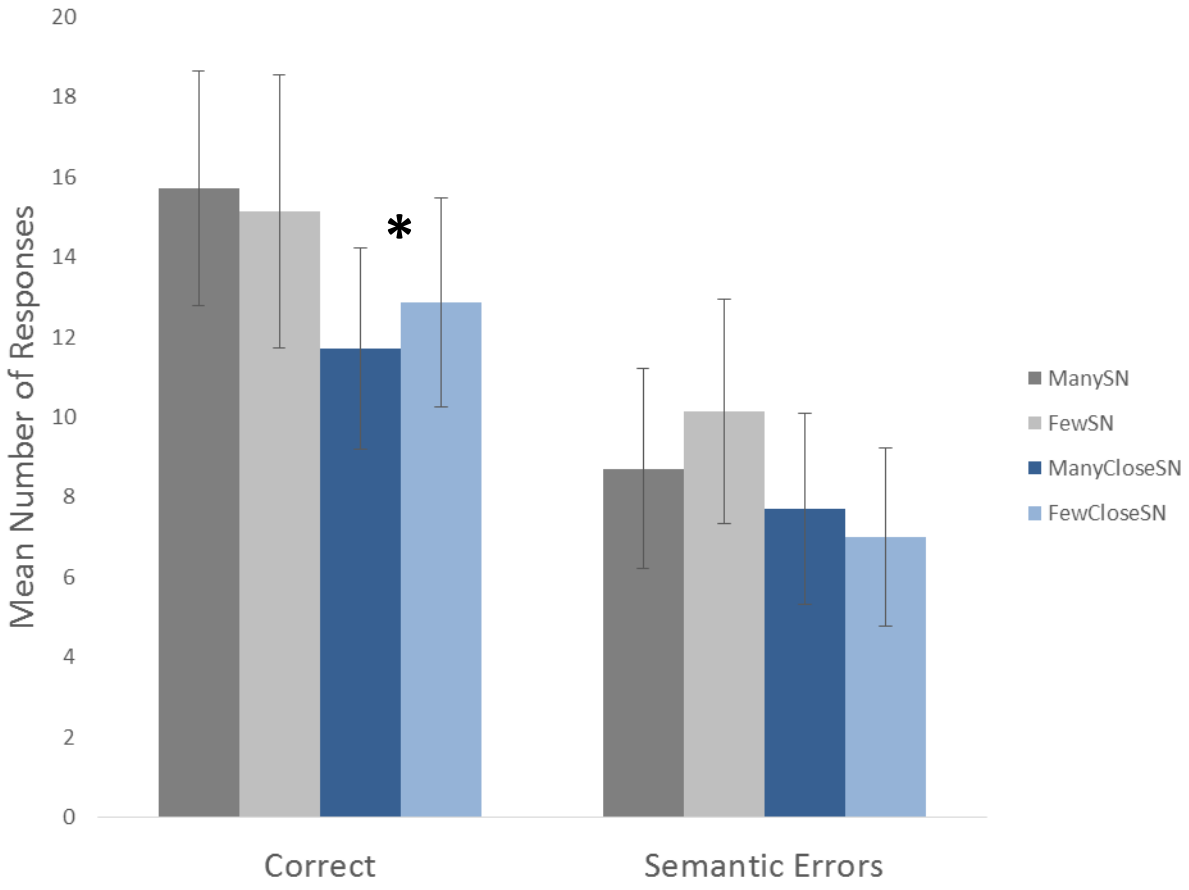


Figure 1. Mean number of correct responses and semantic errors in picture naming of words with many semantic neighbours (SN) compared to words with few SN and words with many close SN compared to words with few close SN.

# Verbal and nonverbal processing of objects and actions in three types of dementia

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There is a growing interest in language impairments in neurodegenerative diseases. Language impairments are regarded as a clinical marker for Alzheimer's disease (Garrard et al., 2005; Forbes-McKay and Venneri, 2005; Cuetos et al., 2007; Berisha et al., 2015) and for primary progressive aphasia for which they are the first clinical marker (Gorno-Tempini et al., 2004; 2011). The analysis of language disorders can provide valuable information about the severity or the stage of dementias and can help in differentiating between different neurological syndromes (Bayles et al., 1989; Kontiola et al., 1990; Mathews et al., 1994; Mendez et al., 2003; Tsantali et al., 2013).
Vonk et al. (2015) showed that for a group of speakers with Alzheimer's Disease verbs and nouns are processed differently. The current study elaborates on this finding. The research question is whether the verbal and non-verbal representation of object and actions are differentially affected. For this, we developed a semantic association task and tested three dementia types: PD with MCI or dementia (PD-D); Alzheimer's Disease (AD); and, frontotemporal lobar degeneration (FTLD).

# Methods

## *Participants*

For the association tasks, 29 native German speaking individuals were included: 9 with AD, 7 with PD-D, 6 with FTLD and 7 with anomic aphasia. Diagnostic assessment was done according to German neurological standards (Leitlinien Deutsche Gesellschaft für Neurologie). The geriatric depression scale (GDS; Yesavage et al., 1983) was used to exclude depression. All participants were assessed with the Mini-Mental State Examination (MMSE; Folstein et al., 1975). The mean MMSE-score were: 22,11 for the AD group; 23,86 for the PD-D group 23,86; 25 for the FTLD group.
All tests were first administered with a group of neurologically intact participants, matched on age, gender and social status. They scored at ceiling on each test and their performance will further be ignored.

## *Material and procedure*

The action tasks involved 40 verbs: 20 instrumental verbs and 20 non-instrumental verbs. Items were constructed by matching each verb with (1) a semantically close related verb (2) a semantically less related verb; (3) a verb which was not semantically related. For the object tasks the 20 nouns related to the 20 instrumental verbs (to cut – a knife; to saw – a saw) were selected.
For the verbal version of the two association tasks, each item was presented on a 21" monitor with touchscreen function. There was one word at the top of the screen. The three alternatives were presented horizontally aligned under the prime word and the participant had to choose which one was most closely related in meaning to the word on top of the screen. For the non-verbal versions, a similar design was used, but now colored photographs of the actions and objects instead of written words were used. There was no time limit and self-corrections were allowed.

# Results

The results are illustrated in Figure 1. A Kruskal Wallis test was used to compare the groups. Post-hoc tests were performed with Mann Whitney U tests.

## *Differences between groups*

No significant differences between the groups were found on the verbal and non-verbal test for objects (verbal: $X=5.17$, $p>0.05$; non-verbal $X=4.97$, $p>0.05$). Differences for both verb tests were significant (verbal actions: $X=11.76$, $p<0.01$; non-verbal actions: $X=11.17$, $p<0.02$).

## *Differences between the tasks*

In comparison to the PD-D speakers the AD speakers had higher scores on the verbal action test. No differences were found between the speakers with FTLD and PD-D.

# Conclusions

The AD speakers were better on the verbal action task than the PD-D group but not on the non-verbal version. No differences were seen with the scores of the FTLD group. In relation to the anomic speakers they scored lower on the non-verbal, but not on the verbal test. The PD-D group showed comparable scores as the FTLD group. They were significantly worse on both action tests than the anomic speakers. The same holds for the FTLD group.

# Literature

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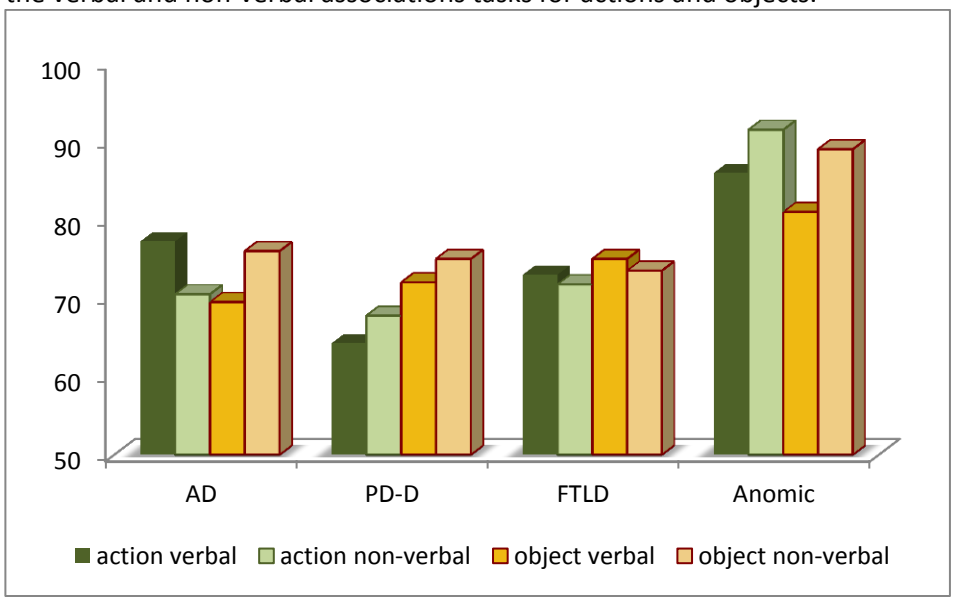
Figure 1: Percentages correct of the 3 dementia groups and the anomic group on the verbal and non-verbal associations tasks for actions and objects.



# Reading Comprehension at the text level:

# Effect of text variables and question type

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## Introduction

Much of our understanding about reading comprehension difficulties in aphasia stems from studies focused on single words and sentences. However, the reading difficulties people with aphasia report are, understandably, with everyday reading activities, and particularly with reading extended pieces, so text level reading (e.g. Parr, 1995, Knollman-Porter et al. 2015). There are some important early studies of paragraph reading (e.g. Brookshire and Nicholas, 1984) but the factors affecting paragraph comprehension for people with aphasia remain poorly understood. This study aims to develop our understanding of the factors affecting reading comprehension at text level in aphasia, with clear reference to the likely variability within the population as a whole.

## Methods

Materials designed to assess paragraph or text level understanding of narratives were developed for the study. These consisted of 15 paragraphs of increasing length (36-523 words), with comprehension assessed via multiple choice sentence completion tasks. The paragraphs were presented on computer, allowing measurement of reading duration time of the paragraph and accuracy of the correspondent sentence completion task. The 56 sentence completion questions were designed to assess comprehension of main ideas and detailed ideas, and stated and implied information (following Brookshire and Nicholas 1984). In each instance, three written choices were presented for each question. After reading all paragraphs, participants were also asked a set of nine questions designed to tap into understanding of meaning developed over time (related to characters within the narratives). Spoken output was not required to avoid a possible confound for people with aphasia.

### *Participants*

People with aphasia were recruited with a simple criteria of having aphasia (with no specification about reading difficulty). The aim was to recruit a diverse sample. A group of healthy participants were also recruited with a range of ages (35-89) as an appropriate comparison group. Data will be presented summarising performance of 162 participants (75 people with aphasia and 87 control participants). Nine people with aphasia were unable/unwilling to attempt this task.

## Results

Unsurprisingly, control participants performed well on the sentence completion tasks (mean ppn correct 91.85; sd 5.51). They found the questions designed to tap into comprehension of overall meaning (or

gist) slightly more difficult (mean ppn correct 80.21; sd 18.67). People with aphasia had a mean of 76.76 (sd 15.46) with lower performance on the gist questions (mean 57.63; sd 23.52) and the ANOVA confirmed this interaction.

In terms of understanding of different types of information, the group (as a whole) showed a significant effect of whether main idea or detail was assessed (with main idea being easier); the same was true for stated and implied information (with stated information easier to comprehend). There was an interaction with group. However, given that the group of people with aphasia had people potentially with and without reading comprehension difficulties, this group was further subdivided into those with and without reading comprehension difficulties. Comparing the two groups of people with aphasia, the effect of main idea being easier compared to detail, and stated information being easier compared to implied information remained, with an interaction with group. The reading comprehension impaired group of people with aphasia found detail more difficult regardless of whether it was stated or implied.

We also considered the effect on performance of variables associated with the paragraphs, considering length (number of words), complexity (Dale-Chall score) and propositional density. However, surprisingly no variable correlated with performance of the three groups, once corrected for the number of correlations.

# Discussion

These results will be discussed in relation to previous findings about understanding of different types of information within text level comprehension. This study found that people with aphasia found the gist (overall meaning) questions particularly difficult; this is potentially significant, given that this may be related to reading books and longer tests. The finding that, in this study, classical measures of reading complexity and paragraph length did not correlate with performance for the groups is unexpected and will be explored. We will discuss implications for assessment of reading comprehension in aphasia and future directions for the research.

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# Exploring spoken and written word retrieval treatment in primary progressive aphasia

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## Introduction

Primary progressive aphasia (PPA) is a neurodegenerative disease, with loss of language functions marking the onset of the disease. Despite the progressive nature of the condition, language impairment in PPA can be responsive to treatment (e.g., Jokel, Graham, Rochon, & Leonard, 2014).

Treatment studies have shown that anomia treatment can be successful in improving word retrieval of treated words, and, importantly, suggest that these words seemed to be somewhat protected from the decline associated with PPA. However, challenges remain regarding the generalisation of these effects to untreated items and to using the treated words outside the context of picture naming (Croot, et al., 2015; Savage, Piguet, & Hodges, 2014).

Furthermore, even though PPA treatment has mainly focused on spoken language, writing and spelling impairment (dysgraphia) is a common feature of PPA (Graham, 2014). Given the often limited resources for speech pathology for PPA (e.g., Taylor, Miles-Kingma, Croot, & Nickels, 2009) a treatment method aimed at improving both spoken and written modalities would be desirable. Only three evaluations of spelling treatment have been reported to date (Rapp & Glucroft, 2009; Tsapkini, Frangakis, Gomez, Davis, & Hillis, 2014; Tsapkini & Hillis, 2013). Moreover, despite PPA being a heterogeneous disorder with three different variants, spelling treatments have only been evaluated for one variant of PPA (logopenic variant).

The current study investigates 1) whether spelling can be improved in the semantic variant of PPA, and 2) whether spelling can provide extra support for spoken word retrieval. This will be investigated using a lexical retrieval treatment used in progressive aphasia treatments (Repetition and/or Reading In the Presence of a Picture; RRIPP: Croot et al., 2015), in a single-case treatment study of semantic variant of PPA. The treatment study will compare the effects of two variants of RRIPP: 1) using spoken naming only, and 2) using a combination of spoken and written naming.

# Methods

## *Participant*

Participant DSN was officially diagnosed with semantic variant of PPA 5 months prior to the start of the study. DSN showed impaired word retrieval and single word comprehension, as well as characteristics of spelling impairment which could be categorised as surface dysgraphia, with phonological plausible spellings for irregular words (e.g., leopard → lepperd) and an effect of frequency in spelling. In the context of his clinical management, he had previously received treatment for word retrieval using repetition in the presence of a picture, carried out as a home programme.

## *Treatment design*

A single case experimental design will be used comprising four weeks of treatment with RRIPP, twice a week. Treatment will include three pre- and two post-therapy assessments in which all treated words as well as a set of untreated control words will be administered for 1) spoken naming and 2) written naming, to test for treatment effects and generalisation. To measure maintenance, a follow up assessment one month after the second post-test will be conducted.

A large set of personally relevant items will be created based on informal conversation with participant DSN and his spouse. Based on pre-treatment accuracy, these items will then be divided into three matched sets (n=40 each): set 1 will be treated in spoken naming treatment (RRIPP) only; set 2 will be treated using spoken and written naming; and the words in set 3 will act as untreated controls.

To ensure that treatment improves word retrieval processes beyond simply associating a lexical item with the picture used in treatment (see Croot et al., 2015), three different picture exemplars of the treated items will be used: one will be used at pre-treatment baseline and post-tests, and another two will be used for treatment.

## *Treatment method*

*Spoken naming (RRIPP):* Pictures of the treated items will be presented one at a time for five seconds, using PowerPoint. Each picture is presented with its corresponding name written below the picture, and with a sound file playing the spoken form. The participant is required to read aloud and repeat the picture name.

*Spoken and written naming:* The presentation of stimuli is identical to the spoken naming (RRIPP) procedure, but in addition to repeating the picture name the participant is also required to write down the picture name.

# Results & Discussion

The study is currently underway. Our research will investigate 1) whether treatment of semantic variant of PPA using RRIPP with personally relevant items results in improved spoken and written word retrieval, and 2) whether adding a written component to a lexical retrieval treatment results in larger treatment gains.

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# Pronoun Processing in Aphasia

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## Introduction

Cross-linguistic studies have identified that people with fluent and nonfluent aphasia (PWA) present with aberrant patterns of pronominal use. Research data from studies that have quantified the morphological and structural aspects of aphasic spontaneous speech have shown variable pronominal patterns between PWA (Bird et al., 2002; Edwards, 1995; Gurland, Chwat, & Wollner, 1982; Hesketh & Bishop, 1996; Rochon, Saffran, Berndt, & Schwartz, 2000; Ruigendijk, 2002; Ruigendijk & Baauw, 2007; Ruigendijk & Bastiaanse, 2002; Ruigendijk, van Zonneveld, & Bastiaanse, 1999; Saffran, Berndt, & Schwartz, 1989; Wagenaar, Snow, & Prins, 1975; Webster, 1999); and, between PWA and people without aphasia. The differential use of pronominal words in spontaneous aphasic speech has been evidenced in the form of abnormal noun-to-pronoun ratios (e.g. over- or under-production), omissions, inappropriate or incorrect substitutions, and inappropriate reidentification of the contextual antecedent. However, these differential patterns of pronominal use have not been systematically studied to determine why the patterns are produced as such.

Difficulty with pronominal processing has been exposed in on- and off-line experimental designs at the sentence-level (Caplan, Waters, DeDe, Michaud, & Reddy, 2007a; Choy & Thompson, 2005, 2010; de Roo, 2003; Edwards & Varlokosta, 2007; Grodzinsky et al., 1993; Kohn et al., 1997; Love, Nicol, Swinney, Hickok, & Zurif, 1998; Love, Swinney, & Zurif, 2001; Piñango & Burkhardt, 2001; Varlokosta & Edwards, 2003), evidencing broad variations of error patterns of pronominal use. As a result of such confounding error patterns, the current literature maintains a steady disagreement regarding the underlying nature of their difficulty. There are different aspects of pronominal processing which may be selectively impaired and may underpin the difficulty observed in their use. One possibility considers the difficulty as a consequence from a word-class dissociation between open- and closed-class words (Andreewsky & Seron, 1975; Bradley, 1983; Bradley & Garrett, 1983; Bradley, Garrett, & Zurif, 1980; Caramazza & Zurif, 1976; Friederici & Schonle, 1980; Gardner & Zurif, 1975; Garrett, 1975, 1980, 1981; Swinney, Zurif, & Cutler, 1980). Another possibility assumes the difficulty is underpinned by a syntactic processing impairment specific to the coreferential processes required when pronominal words are processed implicitly in context (e.g. sentences), within the sentence boundaries (Caplan et al., 2007a; Choy & Thompson, 2005, 2010; de Roo, 2003; Edwards & Varlokosta, 2007; Grodzinsky et al., 1993; Kohn et al., 1997; Love et al., 1998; Love et al., 2001; Piñango & Burkhardt, 2001; Varlokosta & Edwards, 2003). Still, another possibility assumes the difficulty surfaces when pronouns are introduced into discourse and are processed as explicitly discourse-linked elements, simultaneously with other linguistic processes across multiple sentences (Avrutin, 2000, 2006; Bos, Dragoy, Avrutin, Iskra, & Bastiaanse, 2014; Peristeri & Tsimpli, 2013). Contrastively, some literature studies have been unable to evidence error patterns of

pronoun use in PWA when compared to adults without aphasia (Kimbarow & Brookshire, 1983; Ruigendijk, Vasic, & Avrutin, 2006).

The majority of the literature has focused the investigation of pronominal impairment on people with nonfluent aphasia, as this population characteristically demonstrates difficulty with grammatical aspects of language processing. However, people with fluent aphasia have also demonstrated aberrant use of pronominal words. The difficulty observed in both fluent and nonfluent PWA raises the question of whether there is something uniquely difficult about pronominal processing in the aphasic linguistic system, or if pronominal processing difficulties are secondary to other processing difficulties. Therefore, the overall questions remain as to what degree pronominal processing is impaired in PWA; and, what aspect of pronominal words is difficult to process? This study investigated how PWA process pronouns and reflexives at different levels of communication. Particular emphasis was placed on how differential factors in terms of increased syntactic, thematic, and structural complexities (e.g. reversibility, passivization, pronoun competition) may influence pronominal processing in the aphasic linguistic system. Furthermore, this study aimed to understand if different pronominal feature markers are differentially processed or selectively impaired.

# Method

A series of four language experiments were conducted to assess pronominal processing in PWA (13 fluent, seven nonfluent). The experiments investigated: 1) single-word pronoun and reflexive comprehension using a word triad task; 2) pronoun and reflexive comprehension in sentences using a cross-modal sentence-picture matching task; 3) pronoun and reflexive production in sentences using a cross-modal picture description task; 4) pronoun comprehension in discourse using an auditory comprehension task. A generalized linear mixed model (GLMM) (Baayen, Davidson, & Bates, 2008; Gelman, & Hill, 2007) was used to analyze the data collected. The results of pronominal processing at single-word, sentence, and discourse levels from PWA were compared to healthy controls (n=10), and then between aphasia type.

# Results

The findings from the single-word experiment have shown that gender and number pronominal feature markers are processed with more ease (ß=0.776, SE=0.606, z-value=-1.281, p<0.200) when compared to person and case feature markers (ß=0.947, SE=0.473, z-value=-2.002, p<0.045*) in both fluent and nonfluent PWA. The findings from the sentence comprehension experiment have shown that PWA interpret pronouns similarly to healthy controls when processing pronouns as implicit or non-discourse-linked elements under varying levels of syntactic and thematic complexities (ß=1.117, SE=0.668, z-value=1.648, p<0.993). Furthermore, the results from the sentence production and discourse comprehension experiments suggest that people with fluent and nonfluent aphasia process pronouns with significantly more difficulty than healthy controls when processed as discourse-linked elements

(sentence production: ß=3.521, SE=0.531, z-value=6.626, p<0.001*; discourse comprehension: ß=4.155, SE=0.613, z-value=6.780, p<0.001*).

# Discussion

The novel findings from this study have advanced our understanding of pronominal processing in PWA. The findings suggest that the difficulty does not appear to be a result of a pure word-class dissociation between open- and closed-class word processing, nor does the difficulty appear to occur as a global impairment impacting pronominal processing across all levels of communication (e.g. sentences, discourse). Rather, the findings suggest the difficulty is relevant to specific syntactic computations required to build and interpret coreferential links between pronoun referents and contextual antecedents in discourse, whereby pronoun resolution is realized as explicitly discourse-linked processing across multiple sentences.

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# Compound naming in agrammatism: evidence from stroke-induced and primary progressive aphasia

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## Introduction

Recent studies on compound naming in the field of aphasiology (Hittmair-Delazer, 1994; Semenza et al., 1997; Badecker, 2001) report that patients with stroke-induced aphasia are able to retain the knowledge of compound morphological structure despite their inability to retrieve the exact phonological form; this is the so called *compound effect*. Moreover, grammatical class was mainly preserved in constituent substitutions (Mondini et al., 2004), and specific deficits for verb constituents are reflected in verb-noun compounds, suggesting a lexical access through decomposition (Semenza et al., 1997; Marelli et al., 2012; Lorenz et al., 2014). In addition to stroke aphasia, recent studies on Primary Progressive Aphasia, a neurodegenerative disease, have examined inflectional morphology in the agrammatic variant (PPA-a), indicating deficits in the production of correct grammatical endings in verbs (Thompson & Mack, 2014), while derivational morphology has been examined in the semantic variant of PPA only (Auclair-Ouellet et al. 2015, among others). Up to now, Kordouli et al. (under review) dealt with compound naming in PPA-a, suggesting difficulties in verbal compounds and an impaired *lemma* level (Levelt et al., 1989), at later stages of the disease, due to the patient's inability to use morphological rules in order to produce a compound from its constituents.

The present study compares the production ability of Greek-speaking individuals with the agrammatic variant of Primary Progressive Aphasia and agrammatic aphasia caused by stroke (StrAgr) in compound naming. As no studies have been performed up to now on compounding in StrAgr aphasia in MG, our aim is to investigate whether agrammatism affects compound naming in the same way as in these two conditions, one caused by a neurodegenerative disease (PPA-a), and the other by stroke. It is worth noticing that despite the similarities between PPA-a and StrAgr aphasia in morphosyntactic tasks (Thompson et al., 2012), the aforementioned findings in PPA-a regarding compounding (Kordouli et al., under review) differ from previous evidence obtained from StrAgr aphasia. That is, while PPA-a patients seem to have problems in compound naming due to difficulties in morphological operations, StrAgr patients' knowledge of morphological structure remains intact. A difference between StrAgr and PPA-a was also found when it comes to derivational morphology in pseudo-word processing (Manouilidou et al, in prep.). Thus, it is likely that agrammatism manifests itself in different ways in these two disorders. Specifically, based on previous research of StrAgr aphasia in compound naming, which has been confirmed in many languages (see Semenza & Mondini, 2010 for a general review), we expect StrAgr patients to exhibit retained knowledge of the compound's structure (*"compound effect"*), specific problems in verbal constituents and errors in favor of lexical access through decomposition.

# Methods

# Participants

Two PPA-a and one StrAgr patients participated in this study. The StrAgr patient was a 47–year-old-male. PPA-a1 was a 79-year-old-male with ACE-R score 83% (at an earlier stage of the disease), while PPA-a2 was a 58-year-old-female with ACE-R score 47% (at a later stage of the disease). There were also six healthy controls, age: 47-65 years old, native speakers of Modern Greek.

## *Procedure*

Two off-line tasks were conducted, a *picture naming* and a *naming by definition task*. In the first task, participants were shown a set of pictures and they were told to name each picture, while in the second one, they were given the definition of a word and they were instructed to produce the word the definition refers to. They were further instructed to use the words that were given to them in the definition. For instance, *how do we call the house of a doll*? targeting the production of the compound *dollhouse.*

## *Materials and Design*

The stimulus set consisted of 42 nominal compounds (e.g., *kuklospito*/'dollhouse') and 42 simple nouns (e.g., *milo*/'apple'), for the picture naming task, while for the naming by definition task were used 70 dependent (e.g., *αγριογata*/'wild cat'), 45 coordinative (e.g., *alatopipero*/'salt&pepper') and 15 exocentric compounds (e.g., *kokkinomalis*/'redhead') from all grammatical categories.

# Results

PPA-a (reported from Kordouli et al, under review): results showed that only the patient who was at a later stage of the disease differed significantly from the elderly controls [$x^2$=32,5, p<0.001] (see Figure 1). Moreover, her errors were mostly circumlocutions (e.g., *kipos me laxanika*/'a garden with vegetables' instead of *laxanokipos*/'vegetable garden') and single-words (e.g., *violitzis*/'violinist' instead of *organopektis*/'instrument player'), suggesting no compound effect and difficulties in the way compound constituents should be combined, with more problems in verbal compounds. Moreover, no correlation between the number of errors and the type of compound (dependent, coordinative) was found which means that the distinct characteristics of each type, that is, the different semantic relations between their constituents do not affect naming.

StrAgr aphasia: Preliminary data showed a significant difference between healthy controls and StrAgr patient [$x^2$=133,5, p<0.001] in naming-to-definition task. The dominant error types were substitutions (e.g., *krifo**vlepo***/'secretly see' instead of *krifo**kitazo***/'secretly look') and omissions (e.g., *anavo…*/'light on' instead of, *anavo**svino***/'blink'), mostly in the second constituent, and misorderings (e.g., *piperoalati*/'pepper&salt' instead of *alatopipero*/'salt&pepper). Regarding omissions, it is worth noticing that there were prosodic clues which suggested that the StrAgr participant was aware that the response was incomplete and that there was a missing item.

# Discussion

PPA-a affects compound naming only at a later stage of the disease, in which the ability to use the morphological knowledge is disturbed, that is the *lemma* level. These findings are in line with the reported grammatical disturbances which generally characterize the PPA-a variant but are in contrast with previous research in StrAgr aphasia (except for similar problems with verbs), which is supposed to affect the *lexeme* level, that is, the phonological form of a compound (Semenza & Mondini, 2010). On the other hand, StrAgr participant's errors (e.g., substitutions, omissions, misorderings) indicate a preservation of morphological abilities (in some way), providing evidence for a compositional approach to compound production. Upon completion of the analysis, we expect to have an interesting data set regarding the effects of agrammatism in compound naming, in two conditions (PPA & StrAph) which share a lot of similarities but also differences. Overall results will shed further light in morphological operations and how they are affected.

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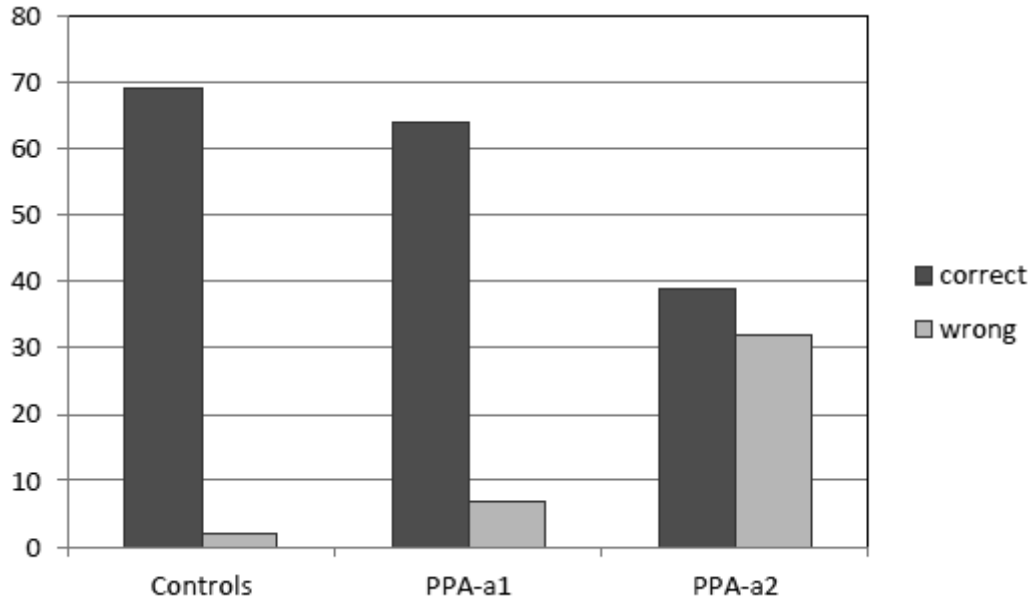

# Improving Naming in Aphasics: A Comparison of Three Intervention methods

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# Introduction

The following study seeks to contribute to the field of aphasia therapy, specifically to the treatment of naming disorders associated with aphasic patients. Word finding difficulty is the struggle of retrieving words and producing them correctly, resulting in inaccurate outputs in either spontaneous discourse or individual word contexts (Rohrer, Knight, Warren, Fox, Rossor & Warren, 2008). This is one of the controversial topics that has been researched over the years. Its importance stems from the vitality of establishing an effective and reliable therapy method that will aid in speech therapy. What differentiates this paper from any other study directed at naming disorder therapy, is the fact that it focuses on treatment methods that are not only effective but are also suitable for patients who are pre-morbidly illiterate, and therefore cannot be treated with conventional therapy methods that involve reading or writing. Many of the aphasic patients in the Arab world, especially those that are old in age, are illiterate, or have not achieved high levels of reading and writing. Therefore, established therapy methods are not very helpful as they involve intact reading and writing skills. Consequently, the need to establish a treatment approach compatible with the literacy criteria of these people is necessary. This study hypothesizes that combining two established therapy strategies into one multi-modal based treatment, with the exclusion of any illiterate incompatible tasks, would provide improved performance for aphasic patients in the word retrieval process. Not only is this paper unique in the sense that it investigates unconventional therapy methods, however, it also examines therapy in the Arabic language. Moreover, the treatment strategy that is designed for this paper is investigated using three presentation methods of therapy, in the aim of finding which is the best treatment method for naming disorders elicited by aphasia?

# Methods

## *Participants*

The participants tested in this experiment were fifteen aphasia patients, where all of them spoke Arabic as a first language. Two types of acquired aphasia were included in the investigation; expressive and anomic aphasia, where all the participants had naming problems. Although naming is one among many general difficulties faced by aphasics (Goodglass, 1980), however it is the most common of impairments (Kohn & Goodglass, 1985). What is more, this deficit is further prominent in anomic aphasia particularly (Papathanasiou et. Al, 2012). For that reason, the participants were a demonstration of both levels of naming disorders; expressive aphasia generally and anomic aphasia specifically. The fifteen participants

were divided into three groups, where each group was matched to type of aphasia, age, gender, degree of severity and date of onset. Although some of the participants are old patients, where naming disorders after 1-2 years start to be residual, however it has been shown that even long after morbidity there is still space for improvement with treatment (Basso et al 1979). There was no control group in this investigation, due to the difficulty of finding non-aphasic subjects that matched each aphasic on the age, education level and identical learning background for the same languages. Therefore, the treatment was compared within the same patient rather than contrasted against a control group. All participants signed a written consent form, agreeing to take part in the study that was granted ethical approval by University of Essex; Language and Linguistics Department.

### *Experimental Design*

The investigation of the multi-modal based treatment is done over a period of 10 days, one speech therapy session per day, taking into consideration pre and post therapy performance, the similarity of all the sessions among all the participants, other contributing factors and the slight but noteworthy individual differences. While ten days is considered to be a short period to treatment, but it has been shown that therapy can improve word retrieval even when it does not last for a long period (Howard et al, 1985). Moreover, three modes of presenting the word lists; laminated cards, iPad photos and real objects were tested and compared, in seek of the best presentation form. The test items were a list of thirty words divided to three sub-lists, where each sub-list appeared in the form of the three conditions. This was done by employing the three sets of words in a Latin square design, available in appendix Table1, so as to eliminate any list presentation effect that might account for one group performing better than the other. With such data collected, it is thus plausible to build conclusions on whether the improvement, if any, is attributed to a therapy method or other factors.

## Results

Statistical Computing Program R was used to analyze the outcomes of the study. The multi-modal based treatment has shown improvements among all participants in the three groups according to the overall percentages of correctly named words before and after treatment; 23.78% and 52.23% respectively. Furthermore, mixed effect logistic regression models were fitted to test for significance before and after therapy, in the three conditions. The pre-therapy accuracy analysis showed insignificant difference between either iPad and laminated cards methods or iPad and real objects methods. These P-values are 0.875 and 0.568 respectively and they confirm the appropriately matched participant groups. Post therapy accuracy analysis suggests significant differences between treatment effects using different therapy methods. The results show highest effectiveness of treatment that introduces real objects, followed by iPad photos therapy and finally laminated cards method. Significant differences ($P<0.001$) were calculated comparing iPad photos method and laminated cards, as well as for differences between iPad photos method and real objects involved therapy.

# Discussion

Overall, the results show that combining two treatment methods into a multi-modal based treatment with the elimination of illiteracy incompatible tasks, would indeed be effective in the treatment of naming disorders for pre-morbidly illiterate patients. Moreover, this investigation provides a reliable resource for speech therapists, especially in the *Arab* world, to refer to when treating *illiterate* and literate aphasic patients with naming disorders using the multi-modal based treatment presented in *real objects*.

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**Table1**

| | **Group A** | **Group B** | **Group C** |
|---|---|---|---|
| **Wordlist1** | Laminated Cards | iPad Photos | Real Objects |
| **Wordlist2** | Real Objects | Laminated Cards | iPad Photos |
| **Wordlist2** | iPad Photos | Real Objects | Laminated Cards |

*Table1. Latin square design of the distribution of the three different methods and wordlists.*

# Thematic and word order canonicity in language: the effect of neurological impairment and age

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## Introduction

Sentences with canonical word order (henceforth syntactically canonical) are those in which the subject, i.e. the nominative-marked argument (S) of a sentence, precedes all other arguments (SVX, where V is the verb). Thematically canonical sentences are those in which higher thematic roles precede lower ones. The highest thematic role is the Agent (the actor of an action), followed by the Experiencer (the emotionally affected argument). The lowest thematic role is the Theme (the argument subject to an action) (Agent>Experience>Theme). Sentences can be both thematically and syntactically canonical but they do not have to. Active SVO sentences with action verbs (Ex. 1a) are syntactically and thematically canonical (Agent-Theme), whereas passive SVX sentences (Ex. 1c) are syntactically but not thematically canonical (Theme-Agent). The same holds for Subject Experiencer verbs (henceforth SubjExp, e.g. *The boy fears the grandpa*), which in active SVX sentences yield the thematic order Experiencer-Theme and in passive SVX sentence the thematic order Theme-Experiencer. This is not the case with Object Experience Verbs (henceforth ObJExp, e.g. *The boy frightens the grandpa*), which in active SVO sentences assign the role of the Theme to the subject and the role of Experiencer to the object (e.g. *The boy frightens the grandpa*), which yields syntactically canonical but thematically non-canonical sentences. Passive SVX sentences with these verbs, in contrast, are both syntactically and thematically canonical.

Concerning language production higher thematic roles are preferably assigned to the subject in both agrammatic (e.g. Lee & Thompson, 2009) and unimpaired language (e.g. Ferreira, 1994), even at the cost of structural complexity. In both studies it has been shown that speakers tend to produce ObjExp verbs in passive sentences in English, which are thematically and syntactically canonical, but structurally more complex. Concerning syntactic canonicity in German, Burchert, Swoboda –Moll & De Bleser (2005) report that agrammatic participants produce SVX sentences more frequently than XVS, whereas no difference was found in the speech of unimpaired participants.

In English, declarative main clauses are syntactically canonical with few exceptions, because the object can precede the subject only under highly restricted conditions. Therefore, thematic canonicity typically affects only voice (active vs passive). In German, in contrast, the order of subject and other arguments is relatively free, which implies that a competition can arise between syntactic and thematic canonicity in sentence production, both for active and for passive sentences.

The aim of this study is to disentangle syntactic from thematic canonicity in production, addressing the effect of age and neurological impairment. To this end we tested three groups of German speakers: persons with mild aphasia, elderly and young neurologically unimpaired speakers. We address the following research questions: 1) Does thematic canonicity override syntactic canonicity or the other way round? 2) Is there any difference among impaired and unimpaired speakers? 3) If yes, is the difference qualitative or quantitative?

# Methods

## *Participants*

Participants consisted of three groups: 1) 5 person with mild aphasia (4 with residual and 1 mild anomic) (mean age: 59, range: 47-71, years of education mean: 13.4, range: 8-17) 2) 4 elderly participants matched for age and education level and 3) 4 students (the data collection of the non-impaired groups is in progress).

## *Experiments: Design and procedure*

Three experiments were conducted. In the first one we manipulated the verb type (action verbs, SubjExp and ObjExp), the word order (SVX vs XSV) and the voice (active vs. passive) of the sentences. Example (1) illustrates the tested structures with an action verb:

(1)

| | | | | | |
|---|---|---|---|---|---|
| a. SVX active: | Der Junge | rettet | den Opa. | | |
| | The boy.nom | saves | the grandpa.acc | | |
| b. XVS active: | Den Opa | | rettet | der Junge. | |
| | the grandpa.acc | | saves | the boy.nom | |
| c. SVX passive: | Der Opa | | wird | von dem Jungen | gerettet. |
| | The grandpa.nom | | is | by the boy | saved |
| d. XVS passive: | Von dem Jungen | | wird | der Opa | gerettet. |
| | By the boy | | is | the grandpa.nom | saved |

We used 12 verbs of each verb class. Sentences were presented auditorily and followed by a digit from 1-9. The participants had to repeat the sentences after counting twice forwards beginning with the digit. Correct responses were those in which the target lexical items were repeated in the target voice and constituent order. In a follow-up experiment, we tested only action verbs manipulating the animacy of

the object. In both experiments we used masculine nouns, which take determiners that are morphologically marked for case.

# Results

If thematic canonicity overrides syntactic canonicity, then we expect to find interaction of verb type by voice and/or order. In the opposite case, we expect an effect of word order. Concerning group differences, we expect the same pattern, as found in previous studies probably with quantitative differences among the groups. In experiment 1 (see figure 1) there was no effect of verb type. We found a group effect (p=0), which indicates that patients performed worse than elderly participants, who performed worse than students. Moreover, we found an interaction of word order by voice for the aphasic and the elderly group (p=0), which indicates that XVS sentences were more difficult only in active voice. The error analysis showed that in this condition elderly and aphasic participants produced SVX sentences, keeping the nouns in the initial serial order, which resulted in semantic reversals (e.g. instead of 'The grandpa.acc saves the boy.nom', they produced 'The grandpa.nom saves the boy.acc'). Crucially, if the object of such sentences with action verbs is inanimate, the semantic reversal yields an implausible sentence (e.g., 'The computer.nom cleans the boy.acc' instead of 'The computer.acc cleans the boy.nom'). Thus, in experiment 2 we manipulated the animacy of the object in order to test whether semantic cues would facilitate the production of XVS active sentences. The results (not reported here) suggest that only elderly unimpaired participants were facilitated by the semantic cues, whereas there was not any effect for the aphasic participants as a group. However, there was individual variability.

# Discussion

Our findings strongly suggest that syntactic canonicity overrides thematic canonicity in German. This holds across elderly groups, whether healthy or neurologically impaired, although to a different extent. We discuss our findings in terms of variations in processing capacities across populations, addressing the implications thereof regarding language abilities in mild/residual aphasia.

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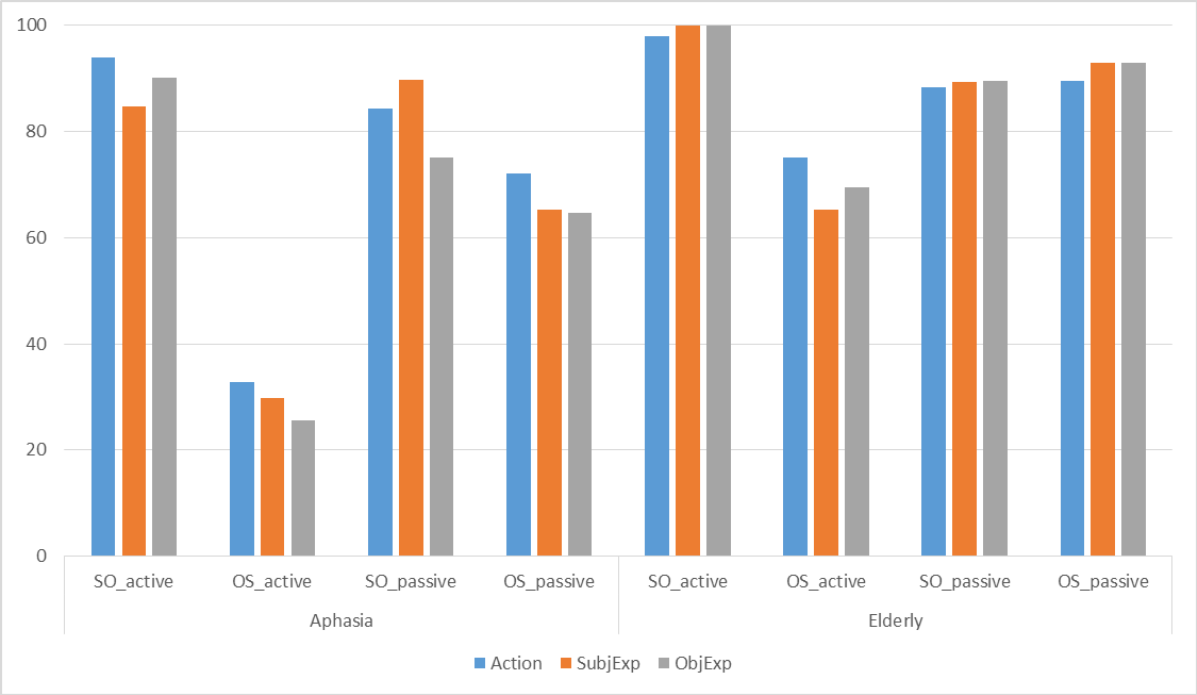


Figure 1: percentage correct responses of the mild aphasic and elderly participants

# Reorganization of cerebral functional activity in persons with aphasia following language therapy

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## Introduction

A currently relevant issue in neurorehabilitation is how brain areas are reorganized during language recovery after brain damage. Previous studies (e.g. Crepaldi et al., 2011; Rofes et al., 2014) showed that the verb naming task has greater diagnostic value than the traditionally used noun naming. Some studies demonstrated activation of inferior frontal gyrus during fMRI naming verbs in healthy individuals (Berlingeri et al., 2008), as well as deficit in patients with lesions in this area (Rapp & Caramazza, 1997). In this study, we investigated functional cerebral reorganization of verb naming after intensive language therapy and its' relation to brain lesion location using fMRI.

## Methods

### *Participants*

Five patients with aphasia (two fluent and three non-fluent; mean age: 51.6; SD = 14.7; 3 men) participated in this study. Two patients (P1and P2) with fluent aphasia had lesions in the posterior part of the left temporal lobe. One patient (P3) with non-fluent aphasia had a lesion in the posterior part of the left inferior frontal gyrus and the insula, and two patients (P4 and P5) had extensive lesions in the left posterior part of frontal lobe, the anterior part of the temporal lobe and the inferior part of the parietal lobe. All the participants were right-handed native speakers of Russian.

### *Therapy*

Verb Network Strengthening Treatment therapy (VNeST; Edmonds, Nadeau, & Kiran, 2009; Edmonds, 2014) was chosen as an intensive language verb therapy, which was modified according to the specifics of the Russian language. This therapy strengthens the activation of semantic networks of a trained verb which spreads to semantically related untrained verbs (Edmonds, 2014). In our study, we used unrelated verbs in the untrained set to see if the generalization would also occur. The patients received individual therapy 5 times a week for three weeks (40 min per session).

### *Verb naming task*

Participants were tested on a verb naming task in and out of the scanner before and after the three week intensive verb therapy. Testing outside the scanner was done on the same set of verbs as in the scanner but in a different order; this was done to assess the accuracy of verb naming. In the experimental condition in the fMRI task, black-and-white action pictures were visually presented on the screen. The patient had to say what the character was doing in the picture. In the control condition, black-and-white abstract images were presented; the patient had to say a pseudoverb “kavaet”. The study was conducted on the Siemens Avanto 1.5 T scanner. fMRI data analysis was performed in SPM8. In the pre- and post-therapy fMRI/behavioral testing, the trained verbs and untrained unrelated verbs were used to assess the therapy effects.

## Results

The pre-treatment accuracy of verb naming (trained + untrained verbs) was 33% (SD = 17,6%). The post-treatment accuracy of verb naming was 50% (SD = 19,4%). The average behavioral change was 17,3% (SD = 12,8%). At the same time, a more pronounced improvement was observed in the trained verbs 26% (SD = 9,5%) compared to the non-trained ones 8,6% (SD = 9,6%).

In the patients P1 and P2 the following was observed: 1) extensive perifocal activation in the left temporal-occipital area; 2) same activations in the left frontal lobe as in healthy participants (which we observed in our previous study (Dragoy et al., 2015)); 3) activation in the right inferior temporal-occipital area; 4) additional bilateral activations in the supplementary motor area (SMA).

In the patient P3 the following pattern was observed: 1) perifocal activation in the frontal area; 2) bilateral activation in the inferior temporal-occipital area; 3) additional activations in the right frontal lobe.

In the patients P4 and P5 the following phenomena were observed: 1) activation in the inferior temporal-occipital areas bilaterally and in the left precentral gyrus; 2) additional activation in the right temporal lobe and the SMA bilaterally; 3) absence of perifocal activation.

After the language therapy, three groups of patients were singled out: 1) significantly increased activations in the left inferior frontal gyrus and the insula were observed in the P1 and P2; 2) in the P3 activation appeared in the left perifocal regions and in the homologous areas of the right hemisphere (RH), and activation in the left SMA decreased (which disappeared at all in the RH); 3) in the patients P4 and P5 we observed increasing activations in the RH, predominantly in the inferior frontal area.

# Discussion

The behavioral data indicate the effectiveness of the therapy, its specificity for the trained verbs and the moderate generalization to naming of untrained unrelated verbs. The therapeutic effects are consistent with the improvements observed in the original studies (Edmonds et al., 2014).

The activation change patterns after the therapy are strongly related to the lesion localization. The recovery of verb naming seems to co-occur with reactivation and involving of inferior frontal lobe if this area is intact. On the contrary, RH activation was observed in patients with the posterior frontal and temporal damage. Our findings contradict the widespread hypothesis proposed by Saur and colleagues (Saur et al., 2006) that the RH activation is only productive at an early stage of recovery and is not productive at the chronic stage. Our data show that if LH is severely damaged, the intensive language therapy leads to productive activation in the inferior frontal area of RH even at the chronic stage. The activation of the RH in the presence of a large-scale LH destruction was also observed in other recent studies (e.g., Anglade et al., 2014).

Thus, our results indicate that the intensive language therapy in patients leads to reactivation of brain areas which are activated in healthy participants during verb naming or to activation of homologous areas in the RH.

# Inhibition and language processing deficits in different types of aphasia

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## Introduction

Since many previous studies reveled that executive control and working memory deficits co-occur with language disturbances and significantly affect them (Hachioui et al., 2014; Murray, 2012; Hula & McNeil, 2008), the current study focuses on the inhibition mechanism which is considered a core process recruited in both executive control and working memory. Although many researchers agree that inhibition is impaired in aphasic individuals, there is now clear agreement regarding the extent of the language specificity of these deficits. Some authors consider inhibition deficits domain-general (Hula & McNeil, 2008; Thompson et al., 2015), whereas others make a distinction between inhibition mechanisms supporting processing of verbal and nonverbal information (Hamilton & Martin, 2005). The main goal of the present study was to investigate verbal and nonverbal inhibition deficits and their role in language comprehension in individuals with fluent and nonfluent aphasia.

## Methods

### *Participants*

Nineteen participants with nonfluent and 17 participants with fluent aphasia were recruited from the Moscow Center for Speech Pathology. Twenty-one participants without aphasia, history of stroke, traumatic brain injury or other neurological diseases comprised the control group. Inclusion criteria were the following: (1) native Russian speaker; (2) dominant right-handedness; (3) preserved visual and/or hearing abilities. The groups did not differ in age, $F(2, 54) = 2.32$, $p = .11$, or in education, $F(2, 54) = 2.15$, $p = .13$. The fluent and nonfluent groups did not differ in the severity of overall language deficits indicated by the total scores from the Quantitative Assessment of Speech in Aphasia (QASA, Tsvetkova, Akhutina, & Pylaeva, 1981), $t(34) = -1.15$, $p = .26$. Aphasia severity varied from mild-severe to light across clinical groups.

### *Materials and procedures*

Overall language comprehension was examined with five *QASA* subtests measuring dialogue, object, action, sentence, and instruction auditory language comprehension. In the *Flanker task*, participants identified the direction of a central arrow on the screen. The task included three conditions: (1) neutral: – – → – – or – – ← – –; (2) congruent: →→→→→ or ←←←←←; and (3) incongruent: ←←→←← or

→→←→→. The Flanker Interference score was measured as the difference in RT between the incongruent and neutral conditions. The *Stroop task* included three conditions. In the condition detecting reading deficits, participants read aloud names of four colors (yellow, red, blue, green) appeared in black ink on the screen. In the second color naming condition, participants named the color of a hexagon (yellow, red, blue, green). In the incongruent condition, participants were asked to name the font color of a word and ignore its name. The name and the color of the ink were always different. The Stroop Interference effects were measured as differences in RT and accuracy between the incongruent and color naming conditions. Additionally, the aphasic participants were tested with the verbal Auditory Attention and nonverbal Rule Finding tasks from the Birmingham Cognitive Screen (Humphreys et al., 2012).

# Results

Both clinical groups were significantly less accurate compared to the controls in the Auditory Attention task (fluent: z = 2.71, $p < .01$, $d = 1.07$; nonfluent: z = -3.94, $p < .001$, $d = 1.68$) and had significantly larger Stroop RT (fluent: z = -3.45, $p < .001$, $d = 1.35$; nonfluent: z = 3.72, $p < .001$, $d = 1.69$) and Stroop Accuracy (fluent: z = -2.55, $p < .05$, $d = .75$; nonfluent: z = 3.27, $p < .001$, $d = 1.10$) Interference scores. For the Flanker Interference scores, no significant differences were found between the clinical groups and controls. In the Rule Finding task, the nonfluent group performed significantly worse compared to the control group (z = -2.13, $p < .05$, $d = .80$), whereas no such difference was found between the fluent and control groups (z = 1.26, $p > .05$, $d = .49$). The clinical groups did not differ significantly in the ability to overcome nonverbal interference in the Flanker task as well as verbal interference in the Stroop task. Moreover, the fluent and nonfluent groups performed relatively similar on the Rule Finding task. However, the nonfluent participants obtained significantly lower scores in the Auditory Attention task (z = -1.92, $p < .05$, $d = .89$).

In the nonfluent group, the majority of the inhibition measures were significantly associated with each other: the Flanker Interference scores were correlated with the Rule Finding scores, $r_s(15) = -.52$, $p < .05$, as well as the Stroop RT Interference scores, $r_s(14) = .64$, $p < .05$; the Rule Finding scores were correlated with the Auditory Attention scores, $r_s(15) = .70$, $p < .01$, Stroop RT, $r_s(14) = -.74$, $p < .01$, and Stroop Accuracy, $r_s(14) = -.59$, $p < .05$, Interference scores; the Auditory Attention scores were significantly related with the Stroop Accuracy Interference scores, $r_s(14) = -.59$, $p < .05$. In the fluent group, the Auditory Attention scores were significantly associated with both Stroop RT, $r_s(13) = -.78$, $p < .01$, and Stroop Accuracy, $r_s(13) = -.66$, $p < .01$, Interference only. In the nonfluent group, the overall language comprehension was significantly associated with the Flanker Interference, $r_s(15) = -.50$, $p < .05$, Rule Finding $r_s(18) = .53$, $p < .05$, and Stroop Accuracy Interference, $r_s(14) = -.53$, $p < .05$, scores. In the fluent group, a single significant association was found between the language comprehension and Flanker Interference measures, $r_s(16) = -.61$, $p < .01$.

# Discussion

Both clinical groups obtained significantly lower scores compared to the controls in the verbal inhibition tasks. The nonfluent group showed significant deficits in the nonverbal inhibition tasks. Moreover, the majority of inhibition scores were correlated among each other in the nonfluent group, but not in the fluent group. These findings suggest that deficiency of a unitary factor can lead to inhibition deficits while processing verbal and nonverbal information in nonfluent aphasia, whereas inhibition deficits are more language-specific in the fluent group. Language comprehension scores were associated significantly with several inhibition measures in the nonfluent group and with Flanker Interference scores in the fluent group. These results demonstrate the role of cognitive deficits in language processing in post-stroke aphasia.

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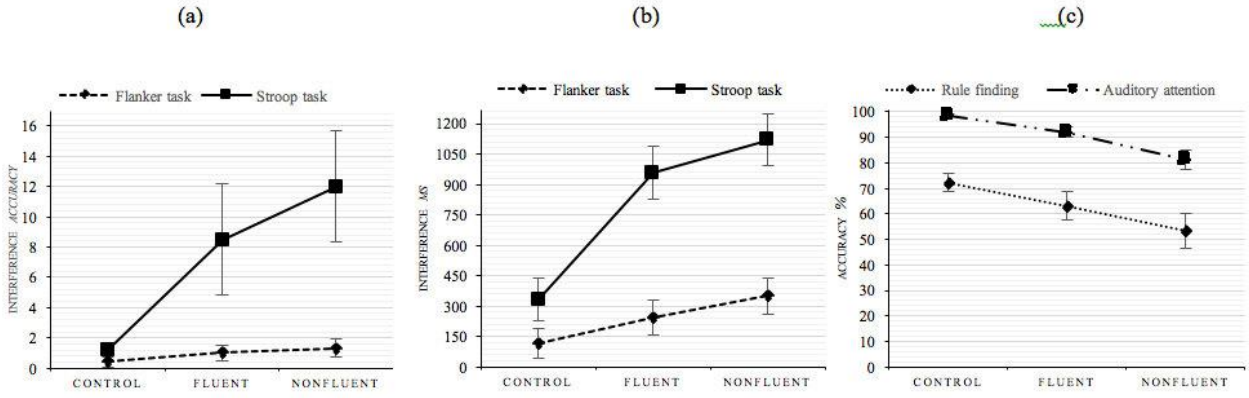
FIGURE 1

Interference scores for (a) accuracy and (b) RT in the Flanker and Stroop tasks and accuracy scores in the (c) Auditory Attention and Rule Fining tasks in the control, fluent, and nonfluent groups



# Subcortical involvement in phonological input processing: an electrophysiological registration study

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# Introduction

The involvement of subcortical nuclei in auditory phonological input processing has only been studied by measuring neuromodulation effects on different aspects of auditory comprehension. Although these phonological effects of subcortical modulation have been well described, it is unclear if phonologically related local field potentials can be elicited in the main subcortical nuclei. Direct registration of event-related potentials (ERP) elicited by language paradigms in the deep brain nuclei is only possible in patients recruited for deep brain stimulation (DBS) as a treatment for their illness. Moreover this registration has to occur shortly after the operation, while the electrode leads are still externalized. The current study applied direct electrophysiological registration of the local field potential activity in the thalamus, subthalamic nucleus (STN) and the pedunculopontine nucleus (PPN) within the first week after DBS-implantation. This research aims to answer the question if the thalamus, STN and PPN are involved in phoneme discrimination and word recognition. If so, what are the temporal and spatial characteristics and how does it relate to the normative data on cortical level?

# Methods

## *Patients*

The current study included 20 right-handed Parkinson's Disease (PD) patients with STN stimulation (mean age 59 (45-71)/9 male, 11 female), 2 patients with thalamic stimulation for essential tremor (mean age 64 (56-73)/1 male, 1 female) and 1 male PD patient with PPN (age 50) stimulation. The imbalanced number of patients corresponds with the prevalence of indications for DBS in the course of

2 years in the centre for Movement Disorders in the Ghent University Hospital.

## *Procedure*

The patients were evaluated in a condition with (ON) and without (OFF) dopaminergic medication. Both conditions were defined using the international accepted CAPSIT protocol (Defer et al., 1999). After the registration in the off-condition the regular morning dose of anti-parkinson medication was given. One hour later, during a practically defined on-condition by the CAPSIT-protocol, the entire procedure was repeated. In the patients starting with the on-condition, the order was reversed.

The first experiment (a phoneme discrimination task) consisted of an auditory oddball paradigm both executed in pre-attentive (MMN) and attentive (P300) condition. The second experiment consisted of a word recognition task where pseudowords were implemented as deviant stimuli and real words as standard stimuli.

## *Materials*

An in-house made interface between the registration device (Neurosoft) and the STN/thalamus/PPN leads was connected to the (temporarily) bilateral externalized STN-contacts. The STN/thalamus/PPN contacts are numbered from 0 to 3, with 0 as the most distal and 3 as the most proximal contact.

## *Analysis*

Data were collected using a 32 channel SynAmp (Neuroscan) amplifier. Electro-encephalographic analysis (ERP-waveform and source localizing) was performed in all nuclei using BrainVision Analyzer 2 (Brain Products, Munich, Germany).

# Results

## *PPN and thalamus*

Within the PPN mid-latency auditory potentials were present. Within the PPN and thalamus no phonologically related long-latency potential could be demonstrated.

### *STN – peak amplitude*

Within the STN a pre-attentive ERP occurred on average in both ON and OFF at a time-window of 64.26 ms (range 62-66.57) and 60.71 ms (range 58.28-63.14) post stimulus for the left and right hemisphere respectively. In the attentive condition a clear ERP was elicited around a time-window of 241.86 ms (range 224.57-259.14) and 241.15 ms (range 217.43-264.86) post stimulus for the left and right hemisphere respectively.

For the word recognition task a clear potential is elicited in the ON-condition for the standard real words on 200 ms, with higher average amplitude in the left hemisphere (Left A= 1.42 μV, Right A=1.29 μV). This ERP was elicited for the left and the right hemisphere at respectively 172.72 ms (range 166.86ms-178.57ms) and 173.72 ms (range 162.29ms-184.14ms) post stimulus onset. In the off-condition an attenuation of the amplitudes on the same timepoints was found.

### *STN – average latencies*

The average latencies of STN evoked potentials for both the pre-attentive ERP (left = 62 ms, Right = 58.28 ms) and attentive ERP (left = 224.57 ms, Right = 217.43 ms) are shorter than the average latencies for cortical evoked potentials in age-matched normal subjects (Pre-attentive ERP= 171 ms and Attentive ERP = 417 ms) out of the normative data of Aerts et al. (2013), suggesting that subcortical phonological components precede cortical phonological processing.

## Discussion

These data suggest an important role of the PPN and STN in the spectrotemporal preparation of phonological input processing and a primary role for the STN in phonological input processing. In comparison with the normative cortical data, these potentials could be detected in a time window prior to the cortical time frame. Within the lateral part of the thalamus no phonological related potential could be detected.

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# Grammaticality Judgements in Aphasia and Parkinson's disease

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# Introduction

In a seminal study Linebarger, Schwartz, and Saffran (1983) found that agrammatic patients retained sensitivity to grammaticality in a Grammaticality Judgement Task (GJT). On the basis of above chance discrimination between grammatical and ungrammatical sentences on many sentence types, they concluded that comprehension deficit in agrammatism did not reflect the loss of syntactic representations. Linebarger et al. (1983) attributed agrammatic comprehension impairment to a failure of mapping from syntactic structure to semantic-thematic roles. This paper remains influential, with a total of 366 Scopus citations, and 52 citations in the last five years.

In this report, we re-examine performance on GJT based on observations that not all individuals with agrammatic aphasia succeed on the task. We examine performance across healthy and brain injured participants, and include a group with Parkinson's Disease (PD) as well as those with aphasia in order to discriminate between specific effects of aphasic impairment and more general effects of brain damage. We explore the variability in performance of aphasic participants across different sentence structures, with the aim of determining the factors that might determine successful grammatical behaviour. Furthermore, we examine if grammaticality judgements are affected by insensitivity to function words, by discovering if errors are more likely to be made on stimuli with a violation located at a function word. We also explore if grammaticality judgements are affected by syntactic working memory by first determining the length of the smallest ungrammatical chunk (SUCL) in the stimuli. An example of a short SUCL is the underlined portion of *"The girls <u>want watching</u> TV"* with the length of 2 lexical items, where as a lexical string (*"want watching"*) cannot be used to create a grammatical sentence. An example of a long SUCL is the underlined portion of *"The man <u>looked the new cars yesterday over</u>"* with the length of 6 lexical items. We then explore if more errors are made on stimuli with a longer ungrammatical chunk length.

Implications include providing input to the current theories in the field, along with putting forth novel findings that would assist in finding the source of processing deficits in agrammatism.

# Method

## *Participants*

20 participants each from four groups were tested: young healthy individuals, older healthy individuals, individuals with PD, and individuals with aphasia.

## *Stimuli*

320 sentences adapted from Linebarger et al. (1983) were utilized for the GJT (Table 1). All stimuli were recorded by a native speaker of English. A pilot study indicated that grammatical/ungrammatical distinction was not signaled by extraneous prosodic cues.

The impact of sensitivity to content and function words on grammaticality decisions was explored, together with the size of ungrammatical chunks. All ungrammatical stimuli were coded on salience and smallest ungrammatical chunk length (SUCL). Salience is defined as the word class (content or function word) of the lexical item at the violation point of the sentence, or whether the violation was signaled by a missing argument. For example, in *"*Have you invite Mary to your party?", "invite"* is coded as a content word. SUCL was coded based on the number of lexical items it contained, whereby this string of lexical items cannot be used to construct a grammatical sentence. For instance, in *"Mary was late class"* the underlined portion is the SUCL with the length of 3 lexical items.

All participants completed a background language and cognitive profile including the Matrix Reasoning test in WASI-II (Wechsler, 2011), PALPA's digit span test (Kay, Lesser, & Coltheart, 1992), and narration of a comic strip. The patient groups were additionally tested on the Boston Naming Test (BNT) (Goodglass & Kaplan, 2000) and the comprehension section of the Comprehensive Aphasia Test (CAT) (Swinburn, Porter, & Howard, 2004).

## *Procedure*

The 320 stimuli were presented on a computer laptop in four blocks of 80 stimuli each to all participants. Participants made grammaticality judgments via mouse buttons. Accuracy and reaction time (RT) were recorded.

# Results & Discussion

We will report patterns of performance between control and patient groups on both accuracy and reaction time. The results will determine which sentence types are more prone to error or slowed responses, and how variables of salience and size of ungrammatical chunks impact upon performance. Furthermore, we will examine interrelationships between background language and cognitive profile and GJT performance.

**Table 1**

| *Type* | *Violation* | *Description* |
|---|---|---|
| **1** | Strict subcategorization | E.g., *He came my house at six o'clock. |
| **2** | Particle movement | E.g., *She went the stairs up in a hurry. |
| **3** | Subject-aux inversion | E.g., *Is the boy is having a good time? |
| **4** | Empty elements | E.g., *The job was expected Frank to get. |
| **5** | Tag questions: subject copying and auxiliary copying | E.g., *The little boy fell down, didn't it? |
| | | E.g., *The young man is fat, isn't she? |
| **6** | Gapless relative clauses | E.g., *Mary ate the bread that I baked a cake. |
| **7** | Phrase structure rules | E.g., *The paper was full mistakes. |
| **8** | Reflexives | E.g., * I helped themselves to the birthday cake. |

Table 1 Eight types of grammatical violations adapted from Linebarger et al. (1983)

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# Better Conversations for people with agrammatic aphasia and their conversation partners? Quantitative outcomes from intervention

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## Introduction

Conversation approaches are increasingly used in intervention with people with aphasia (PWA) and their conversation partners (CPs) although the evidence remains limited, with a reliance on single cases and qualitative evidence of change (Wilkinson & Wielaert, 2012), a situation that is not unusual when a complex behavioural intervention is in the early stages of development and evaluation. Another issue is the paucity of evidence-based approaches, which involve training both PWA and their CPs (Simmons-Mackie et al., 2014). We aim to provide new evidence from a quantitative investigation of change in (i) conversation facilitators (such as multi-modal turns by PWA) and (ii) conversation barriers (such as use of test questions by CPs, ones to which they know the answer already). A comparison will be made between the findings at a group level and for individual dyads of PWA and CP in the case series.

## Methods

### *Participants*

Eight people with chronic agrammatic aphasia and their regular conversation partners participated in this study. All PWAs were more than six month post-stroke, with an age range of 30-71 years.

### *Intervention*

Therapy consisted of a tailored eight week intervention (see Better Conversations with Aphasia 'BCA', available at: https://extend.ucl.ac.uk/). The intervention aimed to raise insight into the effects of agrammatism on conversation, and to teach strategies to allow (i) a PWA to produce more complete, and thus successful, turns at talk, thereby increasing the likelihood of mutual understanding, and (ii) a CP to modify their responses to PWA turns, and thus enhance their partner's chance of communicating more effectively. Participants were facilitated to choose three strategies to work on from a restricted

set of suggestions. The intervention was evaluated directly by measuring change in everyday conversations.

### *Design and outcome measurement*

The study employed a pre-post design with multiple 5 minute samples of natural conversation before and after intervention. Conversation samples were scored by trained raters blind to the point of data collection, using a quantitative measure of conversation behaviour specifically developed for such samples. Eight pre and eight post intervention conversations were compared at a group (paired t-test) and case series level (Poisson Trend Test: employing the Holm-Lezac procedure).

## Results

Group level analysis showed no significant increase in conversation facilitators (mean pre 33.72, post 35.70, t=0.73 (7), 2 tailed p=0.492, n.s., Cohen's d=0.14). There was, however, a significant reduction in the number of conversation barriers (mean pre 8.7, post 2.5, t=2.71 (7), 2 tailed p=0.015, Cohen's d= 0.73).

The case series data revealed considerable variability in conversation behaviours both across occasions for the same dyad and between different dyads (significant tests for homogeneity for both facilitators and barriers indicate real differences between the dyads). There was:

(i) a significant increase in facilitator behaviours for two dyads, a decrease for one dyad and no significant change for five dyads.

(ii) a significant decrease in barrier behaviours for five dyads and no significant change for three dyads.

## Discussion

As advocated by Wilkinson and Wielaert (2012), this study adds to the quantitative evidence base for conversation intervention with adults with aphasia and their conversation partners. Significant changes in conversation behaviour following intervention were found for both PWA and CP. The decrease in the numbers of barrier behaviours used in the sampled conversations was significant for the group and for five dyads although there was an increase in facilitatory behaviours for only two of the eight dyads. Change in behaviour was considerable; on average a reduction from over 8 to fewer than 3 barrier behaviours in 5 minutes of conversation. The quantitative findings reflect real change in participants' views of their conversations (Johnson, 2015).

The pre-post design has the limitation that there is no comparison group. However, the observed changes occur in the conversation behaviours that people with chronic aphasia and their partners themselves chose to target in therapy.

The study supports the use of conversation therapies and, specifically, Better Conversations with Aphasia, suggesting change can occur after eight sessions of intervention targeted for the specific needs

of PWA and their CPs. A reduction in barrier behaviours may be easier to obtain, although the case series findings show that a significant increase in conversation facilitators is also possible. However, we need to explore what factors may be driving the variability of response to this intervention. Consideration of these results, in conjunction with qualitative outcomes and electronically available materials, has implications for goal setting. In particular, we need to investigate further the balance between targeting barriers in comparison with facilitators and the balance between targeting PWA in comparison with CPs.

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# Links between Verbal Short-Term Memory and Receptive Language Impairment in Aphasia

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## Introduction

Individuals with aphasia almost always demonstrate concurrent verbal short-term memory (STM) deficits (Martin, 2000). Language and verbal STM impairments likely coexist due to shared processing mechanisms supporting classic language tasks (e.g. rhyme judgments, word-to-picture matching) and verbal STM tasks (e.g., immediate serial recall of words). According to an interactive linguistic activation model of verbal STM, both task types rely on temporary activation of semantic, lexical, and phonological representations (Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Martin & Saffran, 1997). Receptive language tasks (e.g., word-to-picture matching), are initiated with phonological activation, which then spreads to lexical and semantic representations. Phonological activation is then replenished through feedback from lexical and semantic representations. Similarly, in an immediate serial word recall task, phonological representations are activated first, followed by lexical and semantic representations, which send feedback activation to phonological nodes. Thus, the interactive activation model of verbal STM argues that classic language and verbal STM tasks are supported by a shared underlying temporary storage process that functions via interactive activation of linguistic representations. This idea conflicts with earlier models that assume no direct link between verbal STM and language processing (e.g., Baddeley & Hitch, 1974).

The purpose of the present study was to investigate the connection between verbal STM and receptive language abilities in aphasia by examining the relationship between receptive language impairment type (semantic versus phonological) and effects of serial position, imageability, and frequency in immediate serial recall of words. We predicted that individuals with greater phonological impairment (relative to semantic) would show biases towards correct repetition of the first word (*primacy*), high imageability words, and high frequency words, while individuals with greater semantic impairment (relative to phonological) would show a bias towards correct repetition of the final word (*recency*) and diminished imageability and frequency effects. These predictions were rooted in the interactive linguistic activation model described above, which posits that in repetition, activation spreads from phonological to semantic representations and decays quickly before being replenished by feedback activation. Thus, at time of recall, the first word in a string should be supported more strongly by semantic activation (relative to phonological), because activation has had time to spread to semantic representations. The last word, on the other hand, would be supported more strongly by phonological activation, because activation has had less time to spread to semantics at the time of recall.

# Methods

## *Participants and Procedure*

Twenty-nine individuals with chronic aphasia as a result of a left CVA completed this study. Participants completed a language battery of three receptive lexical-semantic tasks, including the *Peabody Picture Vocabulary Test* (Dunn & Dunn, 1981), a word-to-picture matching test with semantically related distractors, and a synonymy judgment task. Participants also completed a battery of three phonological tasks, including a phoneme discrimination task (with and without an interval between stimuli) and an auditory rhyme judgment task. Composite semantic (S) and phonological (P) scores were created by converting all test scores of a single type (semantic or phonological) into *z* scores and averaging the *z* scores. Relative ability scores were derived by subtracting the phonological score from the semantic score (S-P score). Participants also completed a verbal STM task, which consisted of repetition of auditorily presented word pairs and triplets varied for frequency and imageability. Primacy and recency scores were derived by dividing first and last word percent accuracy, respectively, by total percent accuracy. Imageability and frequency bias scores were derived by dividing percent accuracy on high imageability and frequency words, respectively, by total percent accuracy**.**

## *Data Analysis*

Pearson correlations were performed to determine the relationships between 1) receptive language impairment type (S, P, and S-P score) and primacy/recency effects in word pair and triplet repetition and 2) receptive language impairment type (S, P, and S-P score) and imageability/frequency bias scores in word pair and triplet repetition. Correlations between relative receptive language ability (S-P scores) and verbal STM (primacy, recency, imageability, and frequency biases) were of particular interest, though correlations between individual S and P scores with verbal STM were also performed. Additionally, for word triplets only, a multiple linear regression was conducted to determine whether primacy and imageability biases were uniquely predictive of S-P score.

# Results

Full correlational results are listed in Table 1. For word pairs, two out of four correlations between S-P score and verbal STM were significant in the expected directions: S-P score correlated positively with imageability and frequency biases. In other words, the higher an individual's receptive semantic ability relative to phonological ability, the greater their imageability and frequency biases on word pair repetition. S-P score did not significantly correlate with primacy. Additionally, as expected, P score correlated negatively with primacy, imageability, and frequency. For word triplets, three out of four correlations of interest between S-P score and verbal STM were significant in the expected directions: S-P score correlated positively with imageability and primacy biases and negatively with recency bias. S-P score did not significantly correlate with frequency. Additionally, as expected, P score correlated negatively with imageability, and S score correlated positively with primacy. The multiple regression

analysis with simultaneous entry of primacy and imageability predictors demonstrated that only primacy was uniquely predictive of S-P score, $b$ = .41, $SE$ = .10, $t(25) = 4.05$, $p < .001$, $sr^2$ = .33.

# Discussion

These results support the notion that verbal STM and receptive language abilities are partially supported by a common underlying temporary linguistic activation process, and suggest that effects of serial position and psycholinguistic manipulations (e.g., imageability) observed during verbal STM tasks may provide insights into the nature of receptive word processing impairments in aphasia. Clinically, these results suggest that patterns of serial position and psycholinguistic effects in verbal STM span may serve as useful diagnostic indicators of receptive language impairment type (semantic versus phonological). Because administering a comprehensive battery of lexical-semantic and phonological tests is likely not clinically feasible, serial position and psycholinguistic patterns observed during verbal STM span may serve as an alternative clinical marker of receptive language impairment.

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Table 1.

*Correlation of receptive language impairment type with primacy, recency, imageability, and frequency biases in word string repetition*

| | *df* | Composite S | Composite P | S-P |
|---|---|---|---|---|
| **Word pairs** | | | | |
| *primacy* | 27 | -.04 | -.38 * | .24 |
| *imageability* | 27 | .00 | -.43 * | .45 * |
| *frequency* | 27 | -.41 * | -.74 ** | .37 * |
| **Word triplets** | | | | |
| *primacy* | 26 | .38 * | -.30 | .66 ** |
| *recency* | 26 | -.30 | .28 | -.57 ** |
| *imageability* | 26 | -.21 | -.58 ** | .41 * |
| *frequency* | 26 | -.30 | -.37 | .10 |

* $p < .05$; ** $p < .01$.

*Notes*: 240 word pairs and 80 word triplets were administered. Recency was not calculated for word pairs, as it would yield correlational results reciprocal to those of primacy. One participant did not complete the word triplet task due to floor performance.

# Formulaic Language and Implicit Statistical Learning:

# A Comparison between Typical Development and Children with Acquired Language Disorders

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## Introduction

Production of formulaic language and implicit statistical learning are both observed in typically developing children. Formulaic language consists of word sequences that are prefabricated instead of being generated from linguistic rules (van Lancker Sidtis, 2012). Typically developing children use formulaic language from a young age as a means for further expansion and construction of novel utterances. The ability to acquire formulas may depend on the capacity to detect statistical regularities in language input through implicit statistical learning mechanisms, which has been demonstrated in children as young as 8-months old (Saffran, Aslin & Newport, 1996).

Previous research has investigated the effect of Acquired Language Disorders (ALD) on both capacities. Patients with right hemisphere lesions showed impoverished formulaic language production, while speech samples from aphasic adults with left hemispheric damage indicated the opposite, with unusually high proportions of formulaic language (van Lancker Sidtis, 2012). Furthermore, impaired implicit statistical learning was found in individuals with agrammatic aphasia (Christiansen, Kelly, Shillcock & Greenfield, 2010). However, these studies mainly focused on adult populations. The impact of early Acquired Language Disorders (ALD) on these capacities, and comparisons with typical development, are less well established. This study thus aimed to investigate formulaic language production, implicit statistical learning and the relationship between these two capacities in typical development, as well as compare the performance of this normative profile against a rarely studied aphasic population – children with ALD.

## Methods

### *Participants*

Nine Singaporean children with ALD secondary to neurological events and 20 typically developing controls (aged 6 to 18 years old) participated in the study.

### *Stimuli and Procedure*

Each participant produced a Boston Cookie Theft description (Goodglass, Kaplan & Barresi, 2000). Speech output was analysed with the Frequency in Language Analysis Tool (Zimmerer, Newman, Wibrow & Varley, 2014), a computerized tool that allowed the transcripts to be analyzed quantitatively with frequency information of word combinations from the British National Corpus (BNC; The British National Corpus, 2007). Measures of overall performance (i.e. proportion of connected speech and linguistic errors) and formulaicity were generated.

The participants also completed a non-linguistic Serial Reaction Time Task (SRTT), which involved them responding to visual stimuli appearing on a computer screen via button presses. Unbeknown to the participants, the stimuli appeared in repeating sequences. Reaction time data were analysed and faster responses with increasing exposure to the sequence reflected implicit statistical learning. N-gram models of learning were applied to each participant. Measures of overall performance (i.e. mean reaction time and total errors made) and implicit statistical learning were generated.

Differences between controls and children with ALD in performance, formulaicity and implicit statistical learning measures, as well as associations between these for each participant group, were examined.

## Results

In typical development, age was significantly associated with measures of formulaic language production and implicit statistical learning. In children with ALD, however, none of the measures followed an age-related pattern.

In comparison to children with ALD, controls had more connected speech, fewer linguistic errors and were more formulaic in spontaneous production. Furthermore, a higher proportion of connected speech was associated with higher formulaicity. For the SRTT, both groups showed strongest learning via a bigram model. However, controls showed significantly stronger learning, faster performance and a significant association between the two. Conversely, children with ALD who showed stronger learning were slower, and faster performance was also associated with more errors made.

There was a significant correlation between formulaicity and implicit statistical learning for the controls, whereby a higher proportion of connected speech and higher formulaicity each associated with faster performance and stronger implicit statistical learning on the SRTT.

## Discussion

Data were in accordance with the assumption that overall task performance, formulaicity and implicit statistical learning develop with age for typically developing children but not for children with ALD. As expected, older controls performed better possibly due to more developed language systems, faster information processing and better visuomotor skills as compared to their younger counterparts. They were more formulaic, which might be attributed to increased adult-like productions, and had stronger

implicit statistical learning abilities. Conversely, overall task performance, formulaicity and implicit statistical learning in children with ALD were likely to deviate from normal developmental patterns.

As shown in figure 1, contrary to findings in adult populations (①), the controls' spontaneous productions (②) were more formulaic as compared to that of the children with ALD (③). In typical development, there might be developmental changes across the lifespan, with an initial increase in formulaic language production followed by a possible plateau in adulthood or the ageing process. Alternatively, as the speech samples were compared with those of adult speakers from the BNC, the increase in formulaicity was likely to simply indicate increase adult-likeness in productions. With regard to implicit statistical learning, children with ALD performed poorer and had reduced statistical learning abilities compared to the controls, which could be attributed to decreased processing speed and a greater level of speed-accuracy trade off in motor skill learning.

Overall, the findings were compatible with the view that formulaic language production draws on statistical learning. While there was a relationship between the two capacities, this might be the result of age as a third factor. Further investigation into the type of relationship between the two capacities is needed.

The study protocols were simple, yet sensitive and may have the potential to be used as differentiating measures in detecting language disorders clinically. They may also facilitate the design of novel diagnosis and intervention tools and contribute to therapeutic decision-making. Future research can focus on a specific type of ALD (e.g. non-fluent aphasia) or particular region of brain damage, to investigate the specific neurological mechanisms of formulaic language production and implicit statistical learning. Investigations may also focus on changes and differences in these two capacities across the lifespan.

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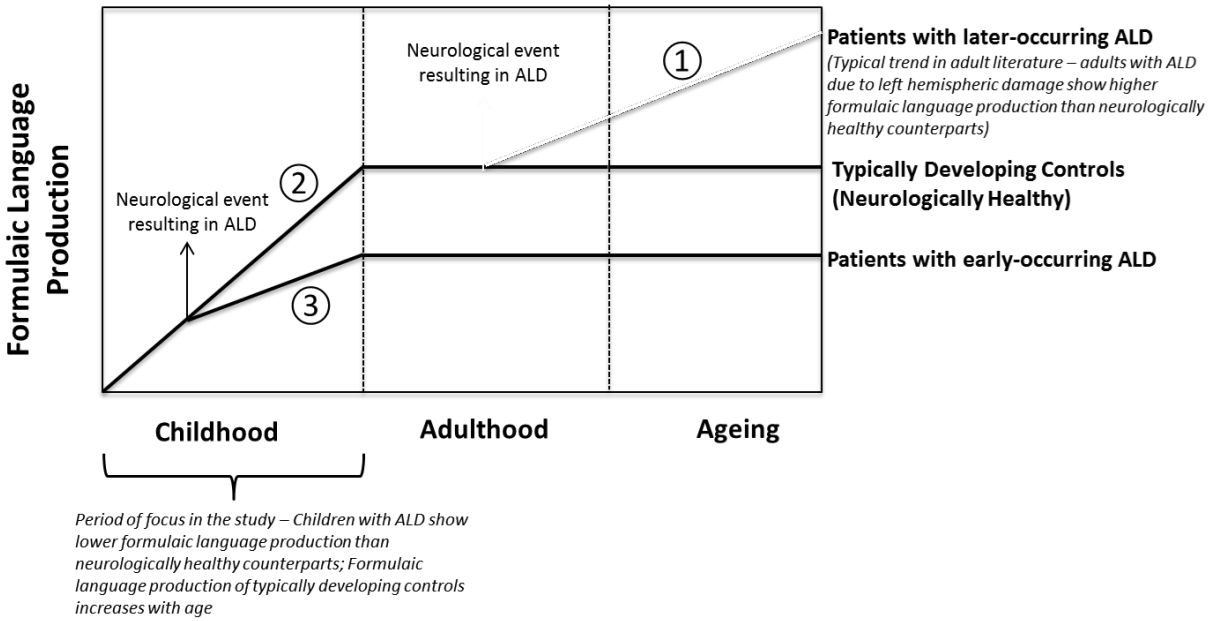
Figure 1: Possible changes in formulaic language production across the lifespan in typically developing controls , patients with early-occurring ALD and patients with later-occurring ALD




*Period of focus in the study – Children with ALD show lower formulaic language production than neurologically healthy counterparts; Formulaic language production of typically developing controls increases with age*

# Time reference and Tense marking in Greek agrammatism. Evidence from narratives and a sentence completion task.

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## Intoduction

Cross-linguistic studies on time reference in highly inflected languages have shown that tense inflection is particularly vulnerable in agrammatic speakers (Bastiaanse et al., 2011; Martinez and Bastiaanse, 2013; Bastiaanse, 2013; Rofes, Martinez, and Bastiaanse, 2014). According to the PAst DIscourse LInking Hypothesis (PADILIH; Bastiaanse et al., 2011), an asymmetry is predicted between past and non-past forms, due to the extra discourse linkage the former type imposes (following Zagona, 2003). However, several other studies do not confirm a clear asymmetry between past and non-past forms (for a review: Faroqi-Shah and Friedman, 2015). Given the limited research on Greek, the present paper aims at investigating whether Greek agrammatic speakers are able to correctly use tense markers with respect to the relevant reference point by employing data from narratives and a sentence completion task with pictures.

## Methods

Seven monolingual Greek agrammatic speakers (mean age: 56.7; SD = 9.01), and a control group of 7 non-brain damaged participants, individually matched to the brain-damaged speakers on age, gender, and educational background, participated in this study. Participants' ability to correctly refer to the past, the future or to the present was assessed by means of (a) a semi-standardized interview, (b) a picture description, and (c) an off-line forced-choice sentence completion task. The semi-standardized interview included two questions to elicit reference to the present, (1), while three questions were administered to elicit reference to the past (2) and to the future (3), respectively. For the picture description, the Flood Rescue picture was used, following Olness (2006). The sentence completion task was based on a short form of the Test for Assessing Reference of Time (TART: Bastiaanse, Jonkers, and Thompson, 2008; for Greek: Koukoulioti, in progress), a sentence priming elicitation task. For the purposes of the present study, we solely assessed the production of 60 sentences in present, past, and future tenses, without including imperfective forms.

(1) *Reference to the present*
Can you describe what you typically do during the day?
Can you shortly describe your family?
(2) *Reference to the past*
Can you describe what happened when you had the stroke?

Can you describe what did you do last summer?

Can you describe what did you do yesterday?

(3) *Reference to the future*
Can you describe what are you planning to do during the summer?

Can you describe what are you planning to do during the weekend?

Can you describe what are you planning to do if you win the lottery?

## Results

Regarding the semi-standardized interview, agrammatic speakers produced significantly fewer verb forms than controls but they managed to produce the verb types expected for each of the questions (Table 1). This indicates that discourse properties are not entirely absent in agrammatism. With regard to the picture description, although statistical differences were obtained among tenses, past-tense forms were mainly used by agrammatic participants. In contrast, controls produced both past and non-past verb forms, and no significant differences were found between tenses. Our agrammatic data from the off-line forced-choice sentence completion task showed greater difficulties in the production of past-tense forms, although reference to the future was also found to be significantly harder than reference to the present. The latter pattern was also confirmed by additional data from a total of 14 agrammatic speakers. Controls performed at ceiling in this task.

## Discussion

Although our results from the sentence completion task are in line with the predictions of PADILIH confirming that reference to the past is more vulnerable than reference to the present or future, reference to the future was also impaired compared to present. This suggests that although tense impairments are evident in agrammatism, asymmetries among tenses are not yet fully explored. We will discuss the impairment in future reference in association to the inferred meanings that future tense involves.

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Table 1. Elicitation data from the semi-standardized interview, picture description and sentence completion task.

| | **Elicitation of Present tense** | | | | **Elicitation of Past tense** | | | | **Elicitation of Future tense** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Total number of verbs produced** | **Total present tense forms** | **Total past tense forms** | **Total future tense forms** | **Total number of verbs produced** | **Total present tense forms** | **Total past tense forms** | **Total future tense forms** | **Total number of verbs produced** | **Total present tense forms** | **Total past tense forms** | **Total future tense forms** |
| P1 | 18 | 12 | 5 | 0 | 27 | 1 | 26 | 0 | 9 | 3 | 0 | 5 |
| P2 | 51 | 19 | 23 | 0 | 128 | 35 | 72 | 0 | 42 | 23 | 3 | 13 |
| P3 | 21 | 18 | 3 | 0 | 55 | 4 | 45 | 0 | 32 | 8 | 1 | 17 |
| P4 | 4 | 3 | 1 | 0 | 10 | 2 | 7 | 0 | 14 | 3 | 0 | 9 |
| P5 | 12 | 3 | 9 | 0 | 16 | 8 | 8 | 0 | 2 | 1 | 1 | 0 |
| P6 | 17 | 12 | 1 | 0 | 25 | 8 | 17 | 0 | 38 | 17 | 1 | 14 |
| P7 | 4 | 4 | 0 | 0 | 9 | 2 | 7 | 0 | 5 | 1 | 0 | 4 |
| **Total** | 127 | **71** | 42 | 0 | 270 | 60 | **182** | 0 | 142 | 56 | 6 | **62** |
| C1 | 27 | 15 | 0 | 7 | 33 | 4 | 25 | 1 | 19 | 6 | 0 | 3 |
| C2 | 28 | 14 | 3 | 0 | 28 | 7 | 17 | 2 | 37 | 8 | 3 | 20 |
| C3 | 38 | 8 | 20 | 2 | 43 | 14 | 19 | 0 | 27 | 11 | 0 | 7 |
| C4 | 16 | 5 | 6 | 1 | 14 | 4 | 8 | 0 | 19 | 6 | 0 | 6 |
| C5 | 24 | 14 | 4 | 5 | 33 | 10 | 17 | 2 | 12 | 3 | 1 | 4 |
| C6 | 36 | 6 | 22 | 0 | 64 | 4 | 42 | 0 | 25 | 6 | 5 | 5 |
| C7 | 21 | 13 | 1 | 3 | 27 | 3 | 23 | 0 | 20 | 7 | 1 | 5 |
| **Total** | **190** | **75** | 56 | 18 | 242 | 46 | **151** | 5 | **159** | 47 | 10 | **50** |

| | Picture Description | | | |
|---|---|---|---|---|
| | **Total number of verbs produced** | **Total present tense forms** | **Total past tense forms** | **Total future tense forms** |
| P1 | 6 | 0 | 6 | 0 |
| P2 | 8 | 0 | 7 | 0 |
| P3 | 12 | 1 | 11 | 0 |
| P4 | 7 | 2 | 4 | 0 |
| P5 | 6 | 1 | 5 | 0 |
| P6 | 12 | 8 | 2 | 2 |
| P7 | 2 | 1 | 1 | 0 |
| **Total** | 53 | 13 | **36** | 2 |
| C1 | 7 | 3 | 1 | 0 |
| C2 | 12 | 3 | 4 | 1 |
| C3 | 26 | 3 | 6 | 4 |
| C4 | 8 | 2 | 3 | 1 |
| C5 | 7 | 1 | 2 | 3 |
| C6 | 14 | 1 | 6 | 0 |
| C7 | 10 | 3 | 3 | 2 |
| **Total** | **84** | 16 | 25 | 11 |

| | Sentence completion task | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** | **P7** | **Total** | **%** |
| **Present** | 18 | 10 | 15 | 20 | 19 | 20 | 19 | 121/140 | 86% |
| **Future** | 20 | 18 | 15 | 4 | 0 | 7 | 14 | 78/140 | **55%** |
| **Past** | 14 | 7 | 2 | 2 | 4 | 8 | 9 | 46/140 | **32%** |

# Language mapping using Object and Action Naming under navigated Transcranial Magnetic Stimulation in a Bilingual and two Monolingual Speakers

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## Introduction

In order to remove brain tumors in eloquent areas, Direct Electrical Stimulation (DES) is used to identify language areas. While this method is considered the gold standard in mapping language onto the regions of the brain (De Witte et al., 2015), it can only be applied intraoperatively. To reduce the operation time and the stress for the patient undergoing surgery, preoperative language mapping using the non-invasive method of navigated Transcranial Stimulation (nTMS) can be of huge benefit (Tarapore, 2016).

nTMS has already led to reliable results in detecting cortical regions responsible for object naming (Rösler et al., 2014) and to some extent for verb generation (Tarapore et al., 2013) in healthy populations. However, there is no protocol to test various functions of language production developed yet. Furthermore, most studies do not include a population that is increasing in number and needs to be object of nTMS research, namely the bilingual population.

We developed a test consisting of both object and action naming for participant-tailored nTMS. This test is meant for brain tumor patients and can be used both before and during the operation. For the current study, we use a Dutch and a German version of both tasks. The research questions for this pilot study are:

(1) Can we identify different brain areas involved in object and action naming?

(2) Are the same brain areas recruited for object and action naming in both languages in a balanced, late bilingual speaker?

# Methods

## *Participants*

Three male participants of the same age group will take part in this study. The bilingual speaker is an L1 German and L2 Dutch late bilingual, who is highly proficient. One L1 German and L1 Dutch monolingual speaker (who both speak English, but are not proficient in Dutch and German respectively) will serve as control subjects. All participants are highly educated. MRI scans of all three participants are available for this study.

## *Material and Design*

The task during language mapping is to name objects (task 1) and actions (task 2). For both tests, 80 pretested pictures of black-and-white drawings depicting objects and actions (see *Figure 1*) are included. The pictures showed a high naming agreement of at least 90% in the pretests. For all nouns and verbs, values of age of acquisition and frequency were acquired and all labels were coded for living/non-living (for the nouns) and transitivity, unaccusativity, instrumentality and name relation (for the verbs).

For the nTMS application, the device visor2$^{TM}$ TMS neuronavigation by the company ANT Neuro b.v. will be used. The intensity and interval of the stimulation is adjustable.

## *Procedure*

To ensure that the picture stimuli are a clear depiction for the participants, a pre-naming session is conducted. The participant is instructed to describe the pictures in a 4 second time window using the lead-in phrases *"This is …*" for objects or "*The man/the woman…"* for verbs (in German and Dutch). The answers will be recorded, as well as the latencies of the answers. Pictures that elicited a different label from what was found in the pretesting will be excluded from the individual participant's stimulus list.

Using the MRI data of the participant, the software of the TMS device creates a 3D digital head model of the participant. Implementing the pointer system, it is then aligned with the physical head of the participant in front of the investigator for accurate placement of the coil.

The individual threshold per participant for stimulation will be determined by stimulating the motor cortex of the vocal apparatus at different intensities, while the participant is naming random pictures. The stimulation frequency that disrupts his speech the most will be chosen as the frequency for language mapping (Rösler et al., 2014).

During the naming tests, the participant will be instructed to name the pictures appearing on screen in front of him in the same way as in the pre-naming test. Each picture will be displayed for 4s. While the participant is trying the name the stimuli, a train of 10 pulses at the predefined threshold will be applied

on different cortical areas for 1s at the onset of the picture presentation. There will be three mapping runs, covering each point of the cortical grid three times. During the whole procedure, the participant is being videotaped and audiotaped for later offline-analysis.

### *Analysis*

The audio-visual recordings of the participants' responses will be scanned for different errors of the following kind: *Speech arrest*, *Anomia*, *Semantic error* or *Phonological error*. If an error occurs 2 out of 3 times for a stimulation point, this point will be marked as a positive site of naming on the 3D map. By this analysis, stimulation maps according to the responses will be obtained. They will be colour-coded for the responses for both object and action naming and for the two different languages for the bilingual participant.

## Results

The data acquisition is currently running and will be completed in time to be presented at the conference.

## Discussion

With the present study, we hope to lay the groundworks for a successful language mapping under nTMS with a dual task for accurate preoperative language mapping in a bilingual brain. The next step will be to take the test to a clinical setting, so that it can be used for pre-operative cortical language mapping in brain tumor patients.

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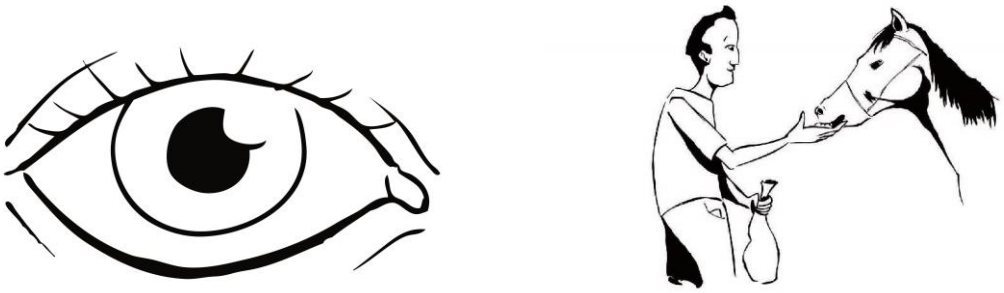

**Figure 1 –** Picture stimuli for object (left) and action (right) naming. The participant should complete the phrases ‘Das ist …’ (this is …) and ‘Er ….’ (he …).

# Computerized assessment of the acoustics of progressive aphasia

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## Introduction

There are two variants of fronto-temporal dementia: a behavioral variant (behavioral FTD, bvFTD, Neary et al. (1998)), which causes changes in behavior and personality but leaves syntax, phonology and semantics relatively intact, and a variant that causes impairments in the language processing system (Primary Progessive Aphasia, PPA (Gorno-Tempini et al., 2004). PPA can be subdivided into subtypes fluent (fluent but empty speech, comprehension of word meaning is affected / `semantic dementia') and non-fluent (agrammatism, hesitant or labored speech, word finding problems). Some identify logopenic aphasia as a FTD-variant: fluent aphasia with anomia but intact object recognition and underlying word meaning.

Mild aphasia can be detected through transcriptions of spontaneous speech (Wolthuis et al., 2014). Spontaneous speech is laborious to transcribe; the use of software can reduce the associated costs, but off-the-shelf speech processing systems are not good enough yet to transcribe speech at the level of detail required in this domain. It is still an open research question which softwaredetectable features that are relevant for diagnosis can be easily obtained with a high degree of certainty.

One example is the acoustic measure: distribution of silence (pause) in spontaneous speech. The difference in silence frequency and duration between a control and a severe patient is visible to the naked eye in visual representations of the sound, cf. figure 1.

We study the usefulness of acoustic and basic textual transcriptions to distinguish the speech of German-speaking controls and patients with dementia caused by (a) Alzheimer's disease, or by (b) frontotemporal lobar generation, either in the form of PPA or of bvFTD. Our goal is to detect and quantify differences as exemplified in figure 1, ultimately scaling to more measurements and patients whose measurements are not as obvious as in figure 1.

Similar studies for English speakers have demonstrated that machine learning based on acoustic and text transcriptions, and richer models, can be used to discriminate between dementia variants and healthy speakers. Previous approaches were successful in discriminating between and controls and respectively: three FTLD-variants (Pakhomov et al., 2010a); four FTLD-variants (Peintner et al., 2008); MCI-patients Roark et al. (2011); fluent and non-fluent PPA (Fraser et al., 2013, 2014a,b); patients with dementia caused by Alzheimer's disease and FTLD-dementia (Jarrold et al., 2014; Orimaye and Golden, 2014).

We focus in this study on those variables that can be measured with the least amount of linguistic transcription: acoustic and textual transcription variables. A realistic model should presumably be based on more transcription detail than just acoustic and textual variables. However, the cost of transcription rises more than linearly with the detail level required for richer models. Before the added costs vs. benefits of richer models can be evaluated, it is important to establish baseline results based on basic transcriptions.

The key contributions of this study are as follows. We examine a small set of auditory and textual measures derived from spontaneous speech samples and use these to discriminate between healthy and dementia groups. We analyze German data and compare this to existing studies with English data. Although prosody plays a similar role in German and English, studies have shown that pitch variation and range are different for the two, and that language-specific cues may be used to indicate boundaries (O'Brien et al., 2014). This may influence the role of such variables in discriminators. We limit ourselves to variables that are easy to acquire with software only, to set a baseline for subsequent research with variables that are more costly to measure.

# Methods

We compare the speech of a control group (n=8) to that of Alzheimer's patients (n=7) and FTD-patients diagnosed with either PPA (n=3) or bvFTD (n=4). Participant recruitment, data elicitation and manual CLAN-annotation are used from a larger study of processing of verbs and nouns in speakers with different types of dementia, currently performed by the second author.

## *Participants*

All participants are native German speakers living in nursing homes in the North of Germany. Patients were selected based on psychologically tests, with a diagnosis made by clinicians according prior to the inception of this study. Controls were selected based on a review by a clinician to exclude those diagnosed with dementia. Spontaneous speech was elicited from each particpant; windows of 1-2 minutes are used for sampling and subsequent transcription and analysis. Participants are monolingual speakers. Controls were matched with patients for age and education.

## *Text transcription*

The speech obtained from each participant was manually transcribed in CLAN by trained linguistics students as part of another longitudinal study. This yields measures of vocabulary at the level of shallow parsing from which variables can be determined, such as frequency of types/tokens, part-of-speech, and word length.

## *Acoustic transcription*

Following the findings of Pakhomov et al. (2010b); Fraser et al. (2013), a statistical model is trained with a selected set of features. Kaldi (Povey et al., 2011), Audacity and Praat (Boersma and Weenink, 2016) were used to detect pauses, mean frequency and variance for F0-F3. Paired with transcriptions, these

yielded variables: pause-to-word ratio, duration of speech, long/short pause count, pause duration, phonation rate, mean recurrence period density entropy (RPDE, Little et al. (2006)).

### *Classification*

Features are selected based on their significance, determined by Welch's t-test. Different classifiers that each make different assumptions of the independence and distribution of variables (Support Vector Machines, Naive Bayes, Random Forests) are trained on the selected features and evaluated for their accuracy using standard leave-one-out cross-validation.The speech obtained from each participant was manually transcribed in CLAN by trained linguistics students as part of another longitudinal study. This yields measures of vocabulary at the level of shallow parsing from which variables can be determined, such as frequency of types/tokens, part-of-speech, and word length.

## Results

The results of two experiments will be reported:

1. Classification accuracy is compared between (a) only acoustic transcriptions, (b) only textual transcription and (c) both;

2. Individual features are ranked based on their discriminative power in each of the classifiers.

Initial results from the experiments will be presented, and a comparison between similar experiments for English as described in the literature (Fraser et al. (2013); Pakhomov et al. (2010b); Roark et al. (2011) *inter alia*) will be discussed.

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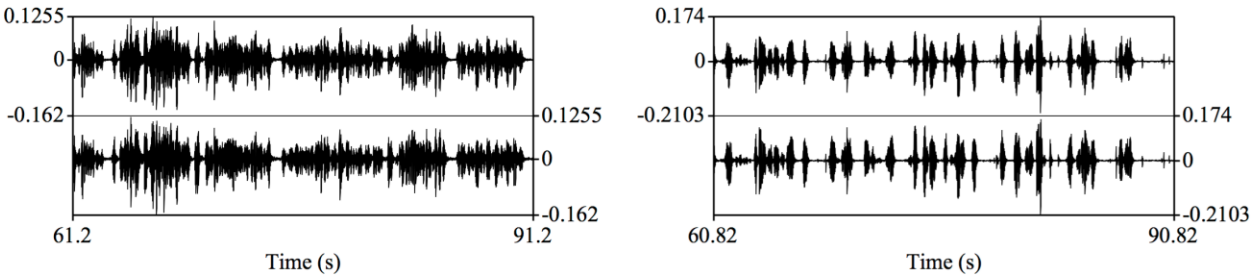


**Figure 1.** Oscillogram of 30 seconds of spontaneous speech of a healthy control (left) and a FTLD-PPA patient (right).

# The Cat in the Tree: What Picture Descriptions Tell us about Event-processing Deficits in Stroke-Induced Aphasia

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## Introduction

Describing an event requires us to transform our general thoughts about that event into a form that we can express as a verbal message - this is known as "conceptualisation" (Levelt, 1989). While thinking and speaking are highly interlinked (e.g., Slobin, 1996), little is known about the influence of speech impairments on the conceptualisation skills of individuals with stroke-induced aphasia (Cairns, Marshall, Cairns, & Dipper, 2007; Dipper, Black, & Bryan, 2005). Single case reports suggest that subjects with conceptualisation deficits tend to produce a large number of irrelevant information units in their picture description, so called "hyper-naming" (Cairns, 2006; Marshall, 2009). Nevertheless, these findings have not yet been replicated in a larger population of individuals with aphasia. Thus, the goal of this study was to gain more information about the prevalence of conceptualisation deficits in a larger population of subjects with aphasia. Moreover, we aimed to identify possible key symptoms of conceptualisation deficits, specifically by examining the number, accuracy, completeness and order of concepts produced in the participants' picture description.

## Method

### *Participants*

We randomly selected 50 healthy older adults (mean age: 72;8 $\pm$ 5;9, 21 female) and 50 individuals with aphasia (mean age: 69;3 $\pm$ 11;4, 25 female) from the AphasiaBank database (MacWhinney, Fromm, Forbes, & Holland, 2011). We excluded subjects with aphasia who did not produce any content words from further analysis and did not count them as participants. 22 subjects with aphasia had been classified as non-fluent and 28 as fluent. The severity of impairment according to the Western Aphasia Battery Aphasia Quotient ranged score from mild (maximum AQ= 96.1) to severe (minimum AQ= 45.5; overall mean AQ = 72.2 $\pm$ 14.4). All participants were right handed and used English as their primary language.

### *Procedure*

We extracted the transcripts of the "Cat Rescue" picture description for every participant in order to perform a concept analysis. We first identified relevant and main concepts from the picture descriptions of healthy controls. In accordance to Nicholas & Brookshire (1995), we defined a relevant concept as a

phrase that contained not more than one verb and provided information that represented the stimulus picture. If a relevant concept was mentioned by more than 60% of all healthy participants, we assigned it as a main concept (Richardson & Dalton, 2016). Following these criteria, we identified nine main concepts and one other relevant concept. These provided the basis for further analyses of the number, order, accuracy and completeness of concepts produced in each participants picture description.

### *Data Analysis*

We evaluated differences in the total number of concepts and number of correctly produced concepts between the control group and the group of individuals with aphasia. Moreover, the performance of each individual with aphasia was compared against the group results. Since some healthy subjects produced very detailed picture descriptions we added a third comparison. We matched controls and subjects with aphasia with regard of their age and total number of concepts and re-analysed differences in their concept order, accuracy and completeness. Finally, we analysed group differences between the picture description performance of non-fluent and fluent participants with aphasia.

## Results

The data analysis is still ongoing so only preliminary results from the first 20 participants with aphasia are presented in this abstract. The outcome of the remaining analyses will be presented at the conference.

The 20 individuals with aphasia produced fewer concepts (see Figure 1) and significantly reduced accuracy and completeness of concepts when compared to the group of healthy controls ($p < .001$, two-sample t-test). Hyper-naming behaviour was not identified in any of the samples. Nevertheless, we found qualitative differences in the order of concepts: The majority of healthy subjects started the description with a concept focusing on the “girl” or the “cat” and mentioned the “man in the tree” next. In contrast, participants with aphasia were less consistent in their order of concept production.

## Discussion

Our preliminary findings suggest that valuable information about the conceptualisation of individuals with aphasia can be gained from their picture description performance. The high variability in the order of production of concepts in the people with aphasia could suggest that some participants had difficulties in extracting the most important information from the picture stimuli and/or in identifying relationships between concepts. However, word retrieval and/ or syntactic deficits might also account for these findings (Cairns, 2006). These possibilities could be discriminated with more detailed assessment. Nevertheless, the picture description analysis presented here provides a possible method for gaining insight into the conceptualisation skills of people with aphasia and thus could inform future diagnostic assessment and treatment.

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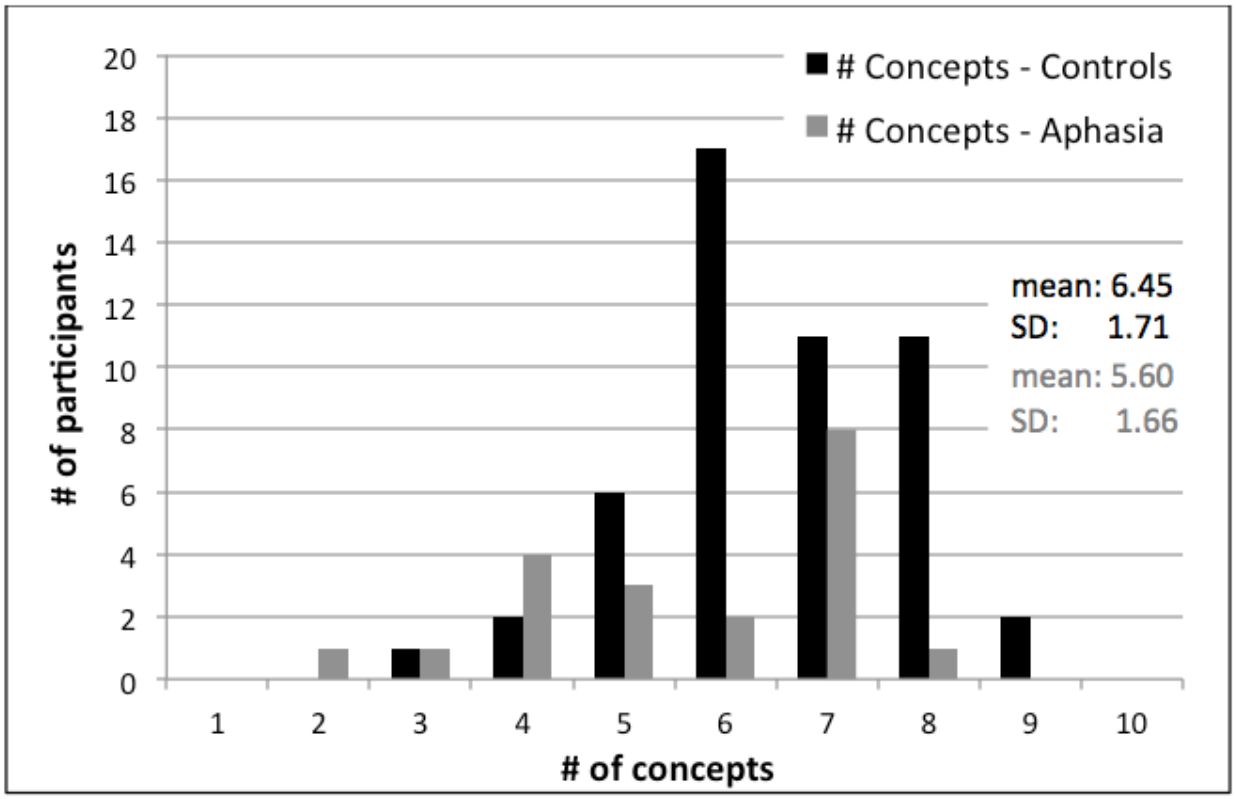


**Figure 1:** Number of concepts produced in the "Cat Rescue" picture description of 20 healthy controls and 20 individuals with aphasia.

# Language preservation in brain tumor patients undergoing awake surgery: Does monitoring object naming suffice to spare other language skills?

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## Introduction

Gliomas often infiltrate (sub)cortical areas involved in language processing. Given the steadily increasing length of survival in patients with low grade gliomas (currently from 5 to >15 years after diagnosis [1]), a critical aim of treatment is to preserve language in order to preserve quality of life and to facilitate return to work [2]. Language is therefore monitored not only before and after surgery, but also during awake surgery, as intra-operative (sub)cortical electrical stimulation allows direct mapping of linguistic functions.

Interest in language assessment in this patient group has increased greatly over the last decades, from evaluations restricted to object naming [3] to the development of elaborate linguistic batteries before and after surgery [4-7]. In most research and clinical practices, however, assessment still focuses mostly on spoken language, and object naming remains the gold standard for intra-operative assessment [4,5,8]. By contrast, the assessment of written language is largely neglected [4,5,10], and, to this day, even elaborate and standardized batteries specifically designed for glioma patients undergoing awake surgery do not include reading and writing [8]. Due to increasing reliance on written language in the technology used in everyday life (eg. smartphones, tablets, computers), reading and writing skills become increasingly important to ensure quality of life. To enhance monitoring of linguistic abilities in glioma patients, peri- and intra-operative language assessment should be expanded to include evaluations of written language [8,9].

Word reading and writing require the ability to process lexical orthographic and semantic information. In addition, reading and writing unfamiliar words involves sublexical conversion procedures (phoneme/grapheme and grapheme/phoneme, respectively). Lesion and neuroimaging studies convincingly demonstrate that written language is processed in brain regions that are at least partly distinct from those involved in spoken language [11]. Moreover, lesion studies in both alexia and agraphia document different neuroanatomical correlates of lexical and sublexical impairments [11]. On these

bases, the question arises of whether current perioperative assessments, focused on spoken language, are sufficiently sensitive to preserve written language and, more broadly, other language skills not explicitly tested perioperatively.

In this study, we inspect if intra-operative monitoring of object naming sufficed to preserve not only spoken naming skills but also other, non-monitored language abilities (nonword repetition, reading and writing), and if impairments at these levels follow the same pattern over time. Spoken and written production are compared in glioma patients after awake surgery to evaluate the ability of the intra-operative monitoring of object naming to preserve language functions.

# Methods

## *Participants*

Six right-handed patients (5 males) who underwent awake surgery for glioma treatment participated (age range: 33-63; education >8 years). They suffered from gliomas of left superior temporal, temporo-occipital and inferior and medial frontal regions. All patients were assessed 1-6 days before surgery, intra-operatively, within 5 weeks after surgery, and at 3-4 months follow-up.

## *Materials*

Four tasks from a cognitive and language test battery [12] are considered in the current study: an object naming task (57-64 pictures), nonword repetition (n=18), nonword reading aloud (n=23) and nonword writing-to-dictation (n=13). All patients completed the four tasks at least pre- and post-operatively. Intra-operatively, the object naming task was used for language mapping.

# Results

On all tasks, error rate increased from pre- to post-operative assessment, to (partly) recover at follow-up (Figure 1). Nonword tasks were significantly worse post-operatively ($t = -2.483$, $p = .024$), while object naming declined non-significantly ($t = -0.630$, $p = .556$). In individual patients, error rates up to 53,9% and 90,9% were found for nonword writing and reading, respectively, whereas nonword repetition and object naming elicited up to 27,8% and 26,3% errors.

From post-operative assessment to follow-up, mild but parallel improvements are observed for object naming and nonword repetition. A parallel but steeper course is observed for long-term recovery of nonword reading and writing. Compared to pre-operative assessments, none of the patients had a higher error rate on object naming at the 3-month follow-up. By contrast, on nonword reading and repetition, two out of three patients produced more errors at follow-up than at baseline.

# Discussion

Language testing in awake surgery typically focuses on intra-operative assessment of object naming and on pre- and post-operative assessment of spoken language. We contrasted error rates on an intra-

operatively monitored, lexical-semantic task (object naming) with those on non-monitored, sublexical language tasks – one involving spoken language (nonword repetition) and two requiring written language processing (nonword reading and writing). We wished also to evaluate whether monitored and non-monitored tasks had a similar post-operative outcome.

Post-operative performance was significantly worse than at baseline on tasks that were not monitored intra-operatively, but not on the monitored object naming task. Overall, post-operative error rates are especially high for nonword tasks engaging written language (reading and writing). Post-operative error rates on object naming and nonword repetition were comparable.

At follow-up, object naming (mapped intra-operatively) was preserved in all participants; performance at the group level was actually better than at baseline. In line with the literature, intra-operative monitoring of object naming preserves object naming skills in these patients. On the other tests, at the group level error rates also decreased in the 3 months after surgery. However, for individual patients, error rates on nonword repetition and reading increased as compared to baseline. In these patients, intra-operative monitoring of object naming did not suffice to preserve non-monitored, sublexical language abilities.

The present study, albeit preliminary, suggests that more severe post-operative deficits may be found on language tasks that are not monitored intra-operatively. It also shows that both written and spoken language may be affected after surgery, underlining that assessment batteries should extend beyond spoken naming, to include written language. The large individual variability observed across tasks emphasizes that both the peri- and intra-operative assessment should be tailored for the individual patient, according to site of tumor.

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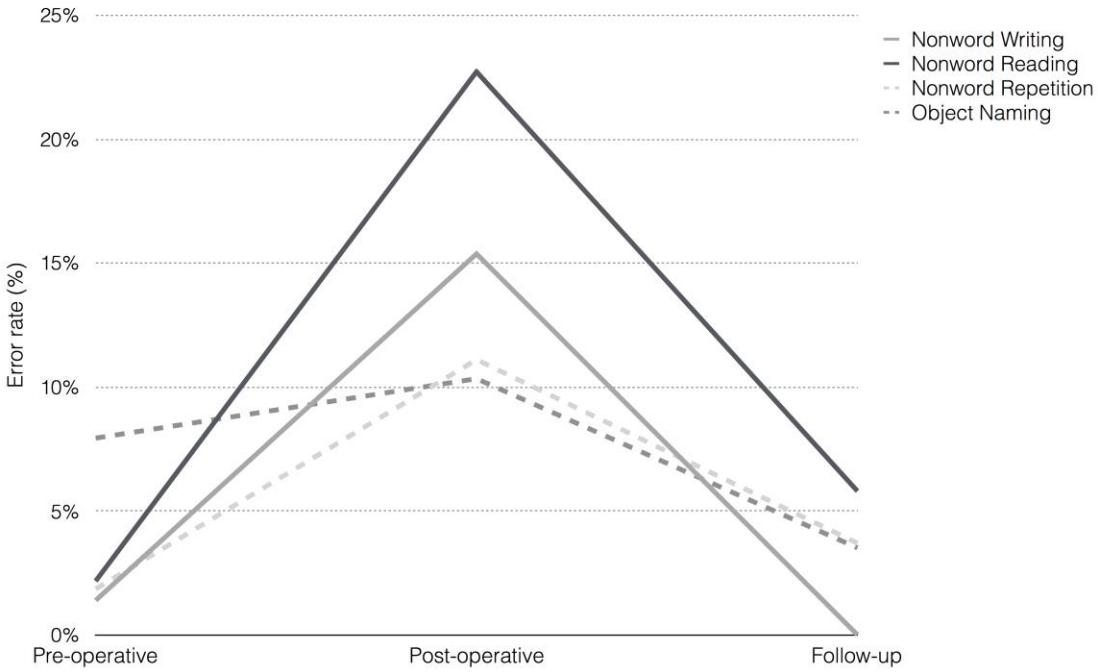


**Figure 1.** Error rates on four tests 1-6 days before surgery (*Pre-operative*), within 5 weeks after surgery (*Post-operative*), and after 3-4 months (*Follow-up*) for all patients together. All six patients were assessed on pre- and post-operative assessment, and 3 patients were also assessed at follow-up. *Nonword Writing* consisted of writing to dictation 13 non-existing words, *Nonword reading* of reading aloud 23 non-existing words, *Nonword Repetition* of oral repetition of 18 non-existing words, and *Object Naming* of oral identification of 57 or 64 pictures.

# Abnormal slow-wave EEG activity in glioma patients is related to impaired language performance

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## Introduction

Gliomas are tumours of the central nervous system that typically infiltrate eloquent brain areas which are essential for sensory, motor and/or language functioning. As a result, glioma patients often suffer from language problems that negatively impact everyday communication (Satoer et al., 2013). Despite intense language monitoring during awake glioma surgery, about half of the patients suffer from language problems after surgery (Santini et al., 2012). These problems still persist after 1 year (Satoer et al., 2014). Our research aims to find predictors for language outcome after awake glioma surgery by analysing recordings of electroencephalography (EEG). EEG is an inexpensive and non-invasive test that is already used in clinical practice for the diagnosis of epileptic seizures. We investigated the occurrence of slow-wave activity in resting-state EEG.

Slow-wave brain activity is assumed to be generated by injured brain tissue and can be observed in the majority of brain tumour patients (De Jongh et al., 2003). Increased slow-wave activity is correlated with poorer cognitive functions in glioma patients (Bosma et al., 2008) and is associated with poorer language performance in post-stroke aphasic patients (Hensel et al., 2004; Szelies et al., 2002). In addition, slow-wave activity in epilepsy patients (without a brain tumour) has been shown to be predictive of memory functioning after temporal lobe surgery (Tuunainen et al., 1995).

It is unknown whether slow-wave activity is related to language functioning in glioma patients and whether or not it has predictive value for language outcome after awake brain surgery. As a first step, we performed a retrospective analysis of patient data.

## Methods

Patient files at the University Medical Center Groningen and the Erasmus MC University Medical Center Rotterdam in the Netherlands were reviewed to search for patients who met the following inclusion criteria:

- awake surgery for a glioma in eloquent brain areas
- ‘presumed’ low-grade glioma (no contrast enhancement on pre-operative MRI scans)
- available EEG and language data (both obtained within the same year, before or after surgery)

Thirteen patients were selected (eight female; mean age= 39 years). Tumours were located in the left hemisphere (85%) or the right hemisphere (15%). They involved frontal and/or temporal areas (77%), parietal areas (8%), or insular areas (15%). The majority of the patients had a low-grade glioma (69%), whereas 31% of the patients appeared to have a high-grade glioma. Four patients had both EEG and language data that were obtained before surgery (pre-operative group) and for nine patients these data were obtained after surgery (post-operative group).

Language data were obtained from a selection of standardised tests (Boston Naming Test, Category Fluency, Letter Fluency and AAT subtests: the Token Test, repetition, reading and writing). The test scores were transformed into z-scores, out of which a mean composite language score was computed for each patient. EEG analysis of slow-wave activity was performed in two different ways: (1) visual analysis: grading of slow-wave activity from normal to very severe (based on Lüders & Noachtar, 2000); and (2) quantitative analysis: calculation of relative slow-wave power in the delta and theta bands (0.5-8 Hz) on artefact-free epochs during eyes-closed resting conditions.

# Results

Eleven out of thirteen patients had a clinically impaired performance ($z<-1.5$) on at least one language test. They comprise two patients in the pre-operative group and nine patients in the post-operative group. Pathologically impaired scores ($z<-2$) were found for two and eight patients, respectively.

The visual EEG analysis showed that patients with normal to moderate slow-wave activity had significantly higher mean composite language scores than patients with moderate/severe to very severe slow-wave activity ($p=.01$). According to quantitative EEG analysis, slow-wave power in the pre-operative group showed marginally significant negative correlations with the scores on Category Fluency ($r=-.95$; $p=.05$) and Letter Fluency ($r=-.95$; $p=.05$). In the post-operative group, slow-wave power only correlated (negatively) with the AAT reading test ($r=-.84$; $p=.02$). An analysis of the whole group (pre + post) revealed negative correlations between slow-wave power and performance on: Letter Fluency ($r=-.68$; $p=.02$), repetition ($r=-.66$; $p=.04$), reading ($r=-.81$; $p<.01$), and the mean composite language scores ($r=-.68$; $p=.02$). The latter correlation is shown in figure 1.

# Discussion

The results show that slow-wave EEG activity is related to language functioning in glioma patients: limited slow-wave activity is related to better language functioning and more pronounced slow-wave activity to poorer language functioning. This holds for verbal fluency pre-operatively, reading ability post-operatively and, irrespective of surgery, the overall language performance. These results are in accordance with previous literature regarding cognitive functions in glioma patients and language performance in stroke patients. The current findings are based on a small sample, however, analysis on a larger group that also examines functional network characteristics of the brain is in progress.

The retrospective analysis merely focuses on the relation between slow-wave activity and language functioning in glioma patients, before or after awake brain surgery. This gives directions for our

prospective study, in which we expect that pre-operative slow-wave activity and functional network characteristics are predictive for language outcome after awake glioma surgery. The outcomes have implications for the counselling of patients and their proxies, and the application of sensitive intra-operative language tests in order to avoid even minor language problems. This is essential for the preservation of the quality of life in glioma patients as their survival rate after awake brain surgery is relatively long.

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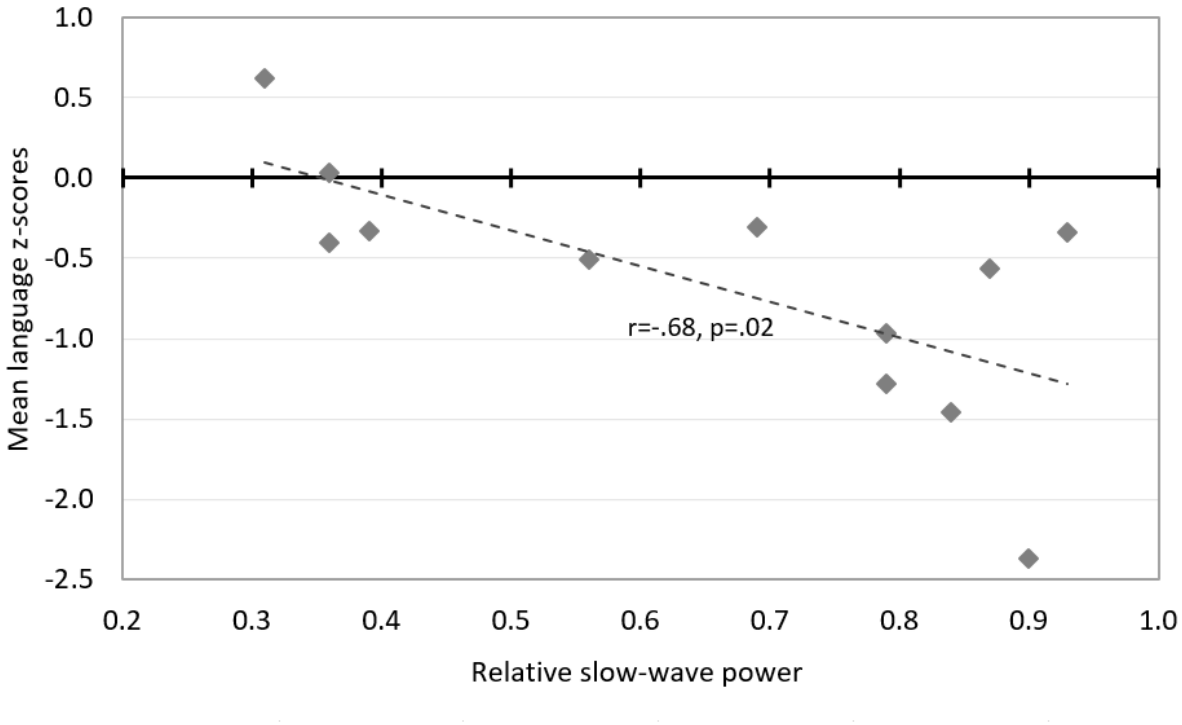


**Figure 1.** Correlation between the mean composite language scores and slow-wave power in the whole group analysis of brain tumour patients (pre + post). Data of 12 patients are presented, because one patient did not have enough artefact-free EEG segments for quantitative analysis.

# Performance consistency as an indication of storage deficit in people with semantic variant Primary Progressive Aphasia

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# Introduction

The primary symptom of the semantic variant of Primary Progressive Aphasia (svPPA) is a progressive loss of knowledge about word meanings, resulting in word-finding difficulties (anomia) and semantic paraphasias, as well as impaired language comprehension (Gorno-Tempini et al., 2011; Patterson & Hodges, 2000). These language specific symptoms have been attributed to a central impairment of the semantic system, a "storage deficit" that in the case of svPPA results in a progressive loss of semantic information (Warrington & Cipolotti, 1996), or, more specifically, loss of specific features of semantic representations (Hodges, Graham, & Patterson, 1995). Evidence for this assumption has been found in picture naming performance of people with svPPA, who have been shown to (1) produce mainly coordinate or superordinate errors and semantic descriptions related to the target item (Budd et al., 2010; Jefferies & Lambon Ralph, 2006), and (2) perform very consistently across tasks and sessions, for example by naming a picture consistently correct or incorrect across several sessions (Hodges et al., 1995). Even though performance consistency is assumed to provide strong evidence for a storage deficit (Warrington & Cipolotti, 1996), only a few studies have assessed consistency of performance in people with svPPA in more detail. At present, studies have focused only on item accuracy either within the same task, in the form of a longitudinal study with several months between sessions (e.g., Hodges et al., 1995), or across different tasks and input modalities (Coccia et al., 2004; Jefferies & Lambon Ralph, 2006). The present study investigated performance consistency of people with svPPA in more detail by assessing consistency in a picture naming task on an item-by-item basis, and not only for accuracy but for different types of error responses. It was the aim to clarify whether consistent naming behavior really constitutes one of the crucial characteristics of an underlying storage deficit in the semantic system and if this is valid only for consistency of accuracy or also of specific error types. .

# Methods

We examined the performance of 10 participants with svPPA (ranging from mild to severe impairment) across three closely consecutive sessions of picture naming. Participants named between 79-124

pictures of personally relevant items. Consistency was assessed in naming accuracy and also in error types, such as semantic errors – one of the most prominent error type in svPPA. This was evaluated using Cohen's Kappa and Logistic Regressions. In addition, we looked at the subtypes of semantic errors that the participants made which provided insights into the structure of semantic representations in the speaker's mind and its breakdown in svPPA.

# Results

The results showed that the participants as a group produced 33% accurate responses and 32% omissions (no responses) across the three sessions. Within the category of semantic errors (29%), coordinate errors (mean of 24%) and semantic descriptions (45%) were the most frequent semantic error subtypes. The analyses on item consistency in naming accuracy revealed that participants were very consistent in their accurate and inaccurate responses (Figure 1). This was indicated by a substantial to moderate Kappa value and a significant increase in Nagelkerke's $R^2$ showing that a regression model including naming accuracy of Sessions 1 and 2 was always the best predictor for responses of Session 3 over and above a set of typical psycholinguistic variables (familiarity, frequency, age of acquisition, imageability and length). For the analyses of error types comparing consistency of semantic errors, correct responses or another error type, Kappa coefficients were lower, but still moderate to substantial for 6/10 participants. The results of the logistic regressions were more varied. For example, naming responses of both Sessions 1 and 2 significantly predicted whether a semantic error rather than another error type was produced in Session 3 for only 3/10 participants.

# Discussion

In line with our predictions for a storage deficit, naming performance of people with svPPA was found to be consistent, particularly regarding naming accuracy. Inaccurate responses were less consistent. These findings can be best explained in a theory of language production which assumes that semantic features constitute semantic representations of objects and that these features are progressively lost in people with svPPA (Hodges et al., 1995). The high consistency in naming accuracy can be accounted for by the consistent availability of semantic features that remained spared from the storage impairment and thus could be used to explicitly identify an object and distinguish it from semantically-related items. For the erroneously named items, while they were consistently named incorrectly, there was variability as to *which* error types (a semantic error or another error response) were produced. The loss of critical (distinctive) features of an item/object can result in the activation and selection of a number of semantically and/or visually similar items, or even in the failure to select an item and thus the production of a no response (omission). Thus, performance consistency can generally inform about a storage deficit in svPPA when distinguishing accuracy/inaccuracy. Further research is needed to gain information about loss of *specific* features leading to consistency of *specific* error types. This will be done in follow-up analyses looking at consistency measures among incorrect responses.

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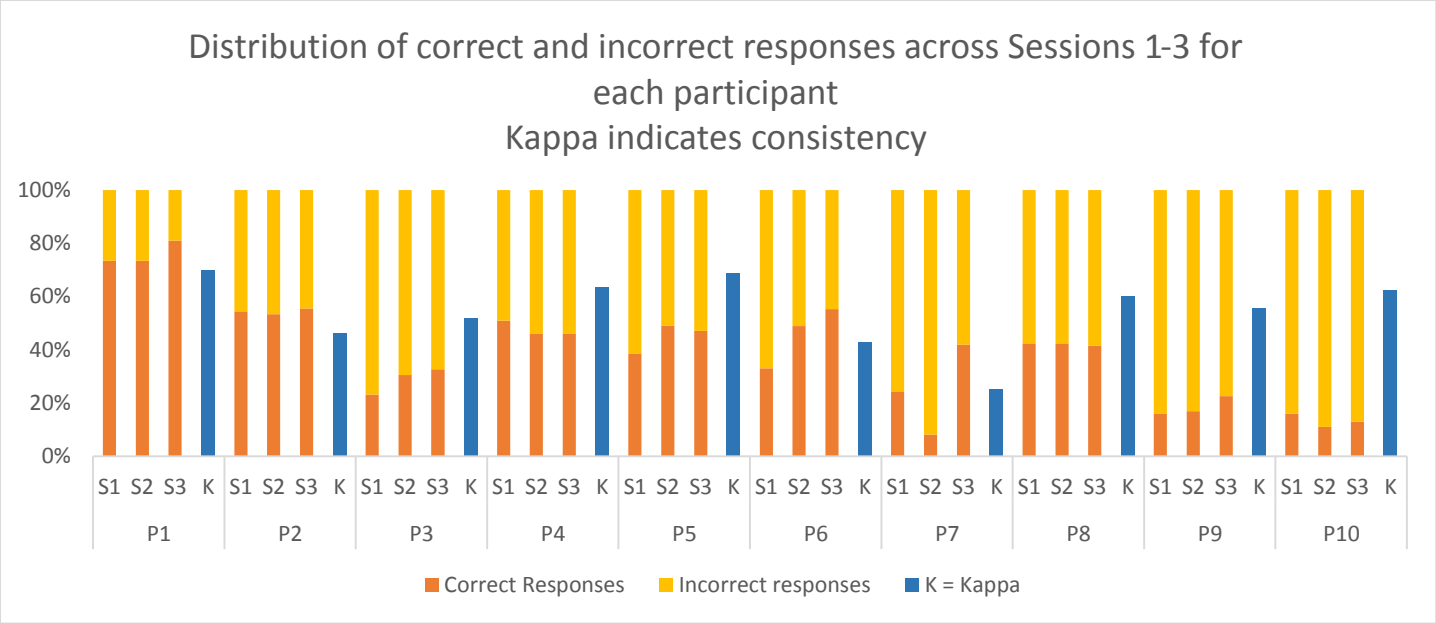


*Figure 2.* Distribution of correct and incorrect responses across Sessions 1-3 for each participant including consistency between sessions as indicated by Cohen's Kappa. Participants are ordered by severity of svPPA, with P1 being the mildest participant.

# The Northwestern Assessment of Verbs and Sentences (NAVS) and the Northwestern Anagram Task (NAT) as tools to assess grammatical deficits in Greek aphasia.

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## Introduction

Up to now only adaptations of the Boston Diagnostic Aphasia Examination (BDAE, Goodglass and Kaplan, 1983) have mainly been used to classify people with aphasia and to assess aspects of language functions in Greek aphasia (Tsapkini, Vlahou and Potagas, 2010; Papathanasiou et al., 2008; Peristeri and Tsapkini, 2011). This tool though proves inadequate to extensively evaluate pure grammatical deficits often seen in participants with agrammatism. The original English version of the Northwestern Assessment of Verbs and Sentences (NAVS) (Thompson, 2011; Cho-Reyes and Thompson, 2012) has widely been used as a clinical assessment of the comprehension and production of (a) verbs with different number of arguments and (b) complex sentences that deviate from their canonical SVO word order. NAVS includes five subtests: (1) verb naming (VNT), (2) verb comprehension, (3) argument structure production (ASPT), and (4) comprehension (SCT) and (5) primed production (SPPT) of canonical (i.e., actives, subject *wh*-questions and relative clauses) and non canonical sentences (i.e., passives, object *wh*-questions and relative clauses). NAVS was recently adapted and translated for use in other languages and cultures (for Chinese: Wang and Thompson, 2015; for Italian: Barbieri et al., 2013). Apart from NAVS, the Northwestern Anagram Task (NAT) (Weintraub et al., 2009) has been used as a clinical measure of sentence production in patients who suffer from speech production, word-finding difficulties, and working memory deficits. NAT requires the assembly of word cards presented in scrambled order into meaningful sentences instead of oral production. Given the lack of assessment tools in Greek available to evaluate verb and sentence deficits, the present study aims at investigating the validity and reliability of the adapted versions of NAVS and NAT as measures of language impairments in Greek-speaking individuals with aphasia.

## Methods

### *Participants*

Eleven non-fluent agrammatic individuals (mean age: 55, SD: 9.8), three anomic individuals (mean age: 54, SD: 8.1), and fifteen age-matched control speakers participated in the study. All brain-damaged participants had suffered a single left CVA at least 16 months prior testing.

### *Materials*

For the adaptation of NAVS the same number of stimuli was used as in the original English version. Familiarity rates, collected from a group of 21 healthy individuals, helped us establish the selection of verbs with different argument structures (i.e., obligatory 1-place (ob1), obligatory 2-place (ob2-), optional 2-place (op2+), and optional 3-place verbs (op3+), while pictures were selected by using a picture norming in a separate group of 23 healthy participants. Additionally, although six sentence types were included in the original version of the SPPT and SCT subtests (three with canonical word order,

such as actives, subject extracted *wh*-questions (*wh*_S) and relative clauses (SR), and three with derived non-canonical order, such as passives, object extracted *wh*-questions (*wh*_O) and relative clauses (OR)), the Greek version does not include passive constructions, since Greek passives are more varied than their English counterparts.

For the adaptation of NAT, the exact same verbs/sentences/pictures used in the SPPT of the adapted Greek version of NAVS were used (passives were also excluded here). In Greek though all NPs carry morphological markers (for case) that can be used as cues to distinguish between agents (e.g., o scilos – the_NOM dog_NOM) and themes (e.g., ton scilo – the_ACC dog_ACC). Thus, for our purposes we decided to present all words as separate individual cards and to add extra cards for both the determiners and each lexical item (in both NOM and ACC case). NAT was administered in a different session to the same participants who completed NAVS.

# Results

The control participants performed at ceiling across subtests in both NAVS and NAT, so their performance will not be further discussed here. In line with the original findings in the English version of NAVS, both the agrammatic and the anomic participants performed significantly worse in the naming of verbs with more arguments compared to those with fewer arguments (see Table 1a). Moreover, verbs with optional arguments were significantly more impaired than those with obligatory ones. Additionally, asymmetries between subject- and object-extracted sentences were attested, with the object ones to be the hardest in production (Table 1a), although a similar tendency was attested in comprehension (in line with previous data from Greek: Nerantzini et al., 2014), with canonical constructions to be significantly better understood compared to non-canonical. Similarly, in NAT, patients performed significantly worse in object-extracted constructions (object *wh*-questions and relative clauses) compared to their subject counterparts (see Table 1b).

# Discussion

Our data revealed impairments in the aphasic speakers' ability to comprehend and produce (a) verbs with complex argument structure and (b) non-canonical constructions. These results are compatible to the ones attested in English, Italian, and Chinese, suggesting that the adapted version of both NAVS and NAT in Greek can successfully be used to assess syntactic deficits in Greek-speaking individuals with aphasia.

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Table 1

a.

| **NAVS-VNT** | **(ob1)** | **(Op2+)** | **(Ob2-)** | **(Op3+)** | | | |
|---|---|---|---|---|---|---|---|
| Agrammatic | 87.2% | 76% | 92% | **47%** | | | |
| Anomic | 100% | 86% | 93% | **73%** | | | |
| | | | | | | | |
| **NAVS-SPPT** | **actives** | ***wh*_S** | ***wh*_O** | **SR** | **OR** | **Total canonical** | **Total non-canonical** |
| Agrammatic | 81% | 41% | 47% | **32%** | **9%** | **46%** | **13%** |
| Anomic | 86% | **86%** | **46%** | **73%** | **33%** | **82%** | **40%** |
| | | | | | | | |
| **NAVS-SCT** | | | | | | | |
| Agrammatic | 92% | 76% | 65% | 78% | 61% | **82%** | **63%** |
| Anomic | 86% | 86% | 60% | 93% | 73% | **88%** | **66%** |

b,

| **NAT** | **actives** | ***wh*_S** | ***wh*_O** | **SR** | **OR** | **Total canonical** | **Total non-canonical** |
|---|---|---|---|---|---|---|---|
| Agrammatic | 97% | **92%** | **60%** | **85%** | **52%** | **91%** | **56%** |

# Is facilitation by phonological cues modulated by the size of the activated lexical cohort?

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## Introduction

Phonological cueing is widely used to facilitate word finding in aphasic patients (Hickin, Best, Herbert, Howard, & Osborne, 2002; Nickels, 2002). Despite its frequent clinical use, the mechanisms underlying phonological cueing facilitation are still debated. Two main explanatory assumptions co-exist: the sub-lexical and the lexical hypotheses. According to the lexical hypothesis, phonological cues affect lexical representations by decreasing the threshold of the words starting with the provided cue. Once processed perceptually, the cue would activate all phonological lexical forms (lexemes) consistent with the supplied cue (here cohort of words beginning with the phoneme) (Starreveld & La Heij, 1995, 1996). Under sub-lexical hypothesis, phonological cue would act at the phonological level only (Lee & Thompson, 2015). Providing the participant a cue sharing phonological information with the target word allow a pre-activation of phonemes shared at the phonological level (Wunderlich & Ziegler, 2011).

The purpose of this work is to investigate the effect of the cohort size activated by the cue on phonological facilitation. Under the lexical hypothesis of phonological facilitation, phonological cues corresponding to a small cohort (few words staring with the same phoneme) should facilitate word finding more than cues activating a larger cohort because they narrow drastically the amount of possible lexical candidates.

## Methods

### *Participants*

The group of healthy subjects was composed of 24 French-speaking undergraduate students aged 19 to 31 years (mean=22.6). They were all right-handed. 15 aphasic participants have been enrolled up to now. They were 43 to 89 years old (mean=66) and suffered from aphasia following focal left hemisphere damage. Time post onset varies from 3 to 6 months and all participants had good oral comprehension.

### *Material and task*

Participants were tested in a picture naming task with black and white line drawings of common objects (72 stimuli for healthy participants and a shorter version of 31 stimuli for the aphasic participants). The pictures were preceded by a phonological cue. The cues consisted of audio-visual video clips of a person

pronouncing the first phoneme of the picture to name (a C with a schwa, eg. [pə] for pencil). Two types of cues were used in each condition: consonants corresponding to low word onset phoneme frequency, corresponding lo the "low cohort" condition (type frequency below 6069 words) and consonants corresponding to high onset phoneme frequency – "high cohort" condition - (type frequency above 9620 words). Each picture was presented in three priming conditions: Matching cue-target condition – Mismatching cue-target condition - Control condition (picture naming without cue).

# Results

The results of the mixed effects regression model on healthy speakers data revealed a main effect of priming on naming latencies ($F(2, 9621.9)=58.5$ ; $p<.001$), with reduced naming latency in the *Matching cue-target condition* compared to the *Mismatching* and the *Control* conditions (Matching condition vs Control: $\beta = 36.6$, $t = 6.95$, $p < 0.001$; Matching vs mismatching conditions: $\beta = 35.4$, $t = 6.70$, $p < 0.001$), but no effect of the cohort size. No main effect is obtained on errors rates.

Naming latencies were analyzed only for the 6 aphasic patients with very low error rates (below 10%) and showed no effect of the cohort size or of the priming condition. On lexical error rates (semantic paraphasias and no responses) of the 9 aphasic patients with errors rate above 10%, a significant effect of the cohort size is observed ($F(1, 1012)=13.32$ ; $p<.001$). Matching cues activating a large lexical cohort significantly reduced lexical error rate compared to cue activating narrow lexical error. No such effect is observed on phonological errors.

# Discussion

While the cohort size activated by the phonological cue does not affect production latencies in healthy subjects and in mild patients, aphasic patients produce less error when the phonological cue corresponds to a large lexical cohort that when it is corresponds to a small cohort. These results are rather in favor of a third assumption of phonological facilitation, namely the hybrid hypothesis (Roelofs, Meyer, & Levelt, 1996) : phonological cues corresponding to a large lexical cohort would allow a stronger activation of the onset segment at the phonological level than cues activating a smaller cohort. These results will be further investigated by including other aphasic participants.

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# Semantic facilitation vs interference in picture naming in a group of fluent aphasic speakers

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## Introduction

Several studies used the blocked cyclic naming paradigm (BCNP) to investigate lexical-semantic context effects on picture naming in healthy subjects. Typical results on reaction times (RT) showed semantic facilitation in the first presentation cycle (Abdel Rahman & Melinger, 2007; Crowther & Martin, 2014; Schnur, Schwartz, Brecher, & Hodgson, 2006) and semantic interference emerging only in subsequent cycles, possibly due to a greater repetition priming in the semantically heterogeneous blocks than in the homogeneous blocks (Navarrete et al., 2014). With aphasic speakers, enhanced semantic interference effects were usually reported in non-fluent patients (McCarthy & Kartsounis, 2000; Wilshire & McCarthy, 2002; Hodgson, Schwartz, Brecher, & Rossi, 2003; Schwartz & Hodgson, 2002; Scott & Wilshire, 2010; Biegler, Crowther, & Martin, 2008; Schnur et al., 2006; Riès, Karzmark, Navarrete, Knight, & Dronkers, 2015), whereas the very few studies testing fluent patients failed to replicate these effects (Wilshire & McCarthy, 2002 ; Biegler et al., 2008). In non-fluent patients, all authors generally agreed that there was a difficulty in modulating activation within the lexical network in aphasic patients (Wilshire & McCarthy, 2002), due to an abnormal prolongation of inhibitory processes, i.e. an over-inhibition (Hodgson et al., 2003; McCarthy & Kartsounis, 2000), an abnormal prolongation of activation processes, i.e. an over-activation (Schnur et al., 2006 ; Biegler et al., 2008) or a deficient « lexical control mechanism » that is unable to minimize the competition of non-target items (Riès et al., 2015; Scott & Wilshire, 2010). Interestingly, all aforementioned studies have focused on semantic interference effects, putting aside semantic facilitation effects and even sometimes discarding the first presentation cycle from the analyses. Therefore, the aim of the present study is to contrast the effects of semantic facilitation and interference occuring in the BNCP in a group of fluent patients.

## Methods

### *Population*

18 French-speaking aphasic persons participated in this study (aged 36-86, mean 63.8). All patients suffered a left hemispheric stroke either 3 months (11 patients) or 6 months earlier (7 patients) and were diagnosed with fluent aphasia at the time of testing. The Boston Naming Test indicated mild anomia in all cases (>80% correct responses). We also tested an extended version of this paradigm in a group of 24 French-speaking young adults, with no significant history of neurological disorder.

### *Material & Procedure*

32 color photographs from 8 different semantic categories were repeated in 3 cycles either in semantically homogeneous blocks (e.g. the target picture « pear » was presented with « pineapple », « orange » and « strawberry ») or in heterogeneous blocks (e.g. « pear » presented with « bus »,

« sheep » and « couch »). Participants were asked to name the pictures as rapidly and accurately as possible. The presentation order of the block type was counterbalanced within- and between-subjects.

# Results

**RT analysis** using linear mixed models showed a main effect of condition ($t=3.172$, $p<.01$) and an interaction between the condition and the cycle ($t=3.396$, $p<.01$) in our group of healthy speakers. Because of this interaction, separate analyses for each cycle were conducted: in the first cycle, naming latencies were shorter in homogeneous blocks vs heterogeneous blocks ($t=2.406$, $p<.05$), in the second cycle, no effect was observed ($t=-.885$, $p=0.38$) and in the third cycle, naming latencies were longer in homogeneous blocks vs heterogeneous blocks ($t=-2.305$, $p<.05$).

**Error rates** in aphasic patients varied between 2% and 44% (mean 10%). Most errors (40%) were semantic errors, 25% phonological errors and 24% omissions (no responses). Generalized linear mixed models showed that relative to heterogeneous blocks, semantically homogeneous blocks increased the error rate only in the third presentation cycle ($z=2.715$, $p<.01$). Omissions and semantic errors (see figure 1) were significantly decreasing across cycles in heterogeneous blocks (respectively: $z=-2.06$, $p<.05$; $z=-2.947$, $p<.01$). In contrast, no effect of cycle was found in homogeneous blocks (respectively: $z=-1.904$, $p=.06$ $z=1.423$, $p=.16$). In heterogeneous blocks, a similar proportion of semantic errors was observed from within the response set (52%) or external (48%), but in homogeneous blocks, semantic errors were predominantly part of the response set (72%).

# Discussion

Using a BCNP in healthy speakers, we observed semantic facilitation in the first presentation cycle, but interference in the third cycle. In aphasic speakers we only observed interference in the third presentation cycle. Crucially, interference appeared although our group consisted of patients with fluent aphasia, whereas in previous studies only non-fluent aphasic speakers showed to be sensitive to semantic interference. Interestingly, omissions and semantic errors decreased across cycles only in semantically heterogeneous blocks, but not in homogeneous blocks. These results are in line with an hypothesis of a differential repetition priming in homogeneous and heterogeneous conditions (Navarrete et al., 2014). Moreover, the predominance of semantic errors from within the response set in homogeneous blocks is rather in line with an over-activation hypothesis (Schnur et al., 2006 ; Biegler et al., 2008) and/or a difficulty to minimize the competition of non-target items (Riès et al., 2015; Scott & Wilshire, 2010).

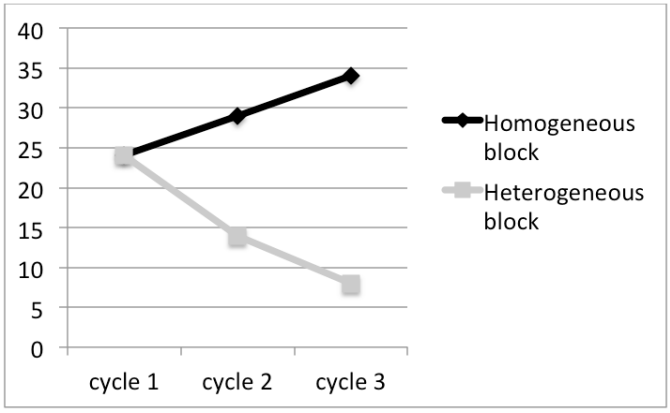


*Figure 1: Total number of semantic errors per condition across cycles*

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# Word imageability from a cross-linguistic perspective

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## Introduction

Imageability ratings are obtained by asking people to evaluate the degree to which they think a word can be mentally depicted (Paivio et al., 1968). People with aphasia retrieve high-imageability words more accurately than low-imageability words (Luzzatti et al., 2002; for the reverse pattern see Berndt et al., 2002). Therefore, it seems necessary to control for this variable when designing test materials, as failing to do so may affect our overall interpretation of the results. Furthermore, imageability ratings may grant a better understanding of differences at the semantic/lexical level (Bastiaanse & Van Zonneveld, 2004), as high-imageability words are richer in perceptual features than low-imageability words (Plaut & Shallice, 1993). After the pioneering norms by Paivio and colleagues (1968), extensive databases have been constructed for English (e.g., Bird et al., 2001; Coltheart, 1981; Cortese et al., 2004), Italian (Rofes et al., 2015), Swedish (Blomberg & Öberg, 2015), Norwegian (Simonsen et al., 2013), and other languages. However, there is a lack of understanding on how consistent imageability ratings are across languages.

Understanding imageability ratings in different languages may provide stronger grounds to advocate for lexical/semantic similarities across languages. In fact, it may be reasonable to think that concepts such as 'apple' and 'house' are easy to imagine for speakers of the same language and also for people who speak different languages. However, this may not be true for concepts that are dependent on cultural or socio-economic factors, such as 'table' or 'priest'. For example, Blomberg and Öberg (2015) reported a strong positive correlation between English and Swedish imageability ratings and argued that imageability ratings "can be reliably transferred between the two languages, although some caution should be taken, since for some individual words, some ratings might differ substantially". Existing ratings in one language may also be used as approximate measures for other languages. For example, the validity of new ratings obtained in a less studied language may be compared with those of semantically equivalent words of a more studied language.

In the present study, members of Working Group 2 of the Collaboration of Aphasia Trialists [COST IS1208] joined efforts to compare imageability ratings between English and nine other languages (Catalan, Croatian, Hungarian, Italian, Norwegian, Serbian, Spanish, Swedish, and Turkish), and across two different English databases. We expected to find strong positive correlations between the different databases provided that the words entered in the correlations refer to concepts that have a similar meaning.

# Methods

Eleven imageability databases were considered. These corresponded to unpublished data collected within the COST collaboration for Catalan (202 words, 32 informants – university undergraduates), Croatian (608 words, 27-46 informants, mean age=44, sd=18), Hungarian (207 words, 30-37 informants, mean age=44, sd=12), Serbian (82 words, 30 informants, mean age=31, sd=12), Spanish (256 words, 20 informants, mean age=22, sd=5), Swedish (190 words, mean age=41, sd=17), and Turkish (176 words, 51 informants, mean age=21; sd=1), and to the published imageability ratings for English (Bird et al., 2001; 2645 words, 78 informants, mean age=65; sd=9; and Cortese et al., 2004; 3000 words, 31 informants – university undergraduates), Italian (Rofes et al., 2015; 292 words, 50 informants, mean age=28, sd=11), and Norwegian (Simonsen et al., 2013; 917 words, 399 informants, mean age=38, sd=16).

Imageability ratings for all databases were obtained following the same instructions (Paivio et al., 1968). Some differences between the databases existed in terms of the number and mean age of participants, number of items, or the modality that was used to collect the ratings (on-line questionnaires vs pen-and-paper, informants were presented one word at a time vs list of words, or independent groups of informants responded to two independent parts of one list). To obtain a sufficient number of items to run statistical analyses, we considered correlations between the English databases of Bird et al. (2001), and Cortese et al. (2004), and the other databases, including a correlation between the two English databases. The number of semantically equivalent words between each of the two English databases and each of the other languages (e.g., *apple* and *mela* in Italian) ranged between 15 and 467 words. The Norwegian and Hungarian databases only included nouns.

# Results

The results are shown in Table 1. The ratings in all databases correlated significantly with the ratings in the English database of Cortese et al. (2004). Ratings in the database of Bird et al. (2001) did not correlate with the ratings in the Catalan, Serbian, and Turkish databases, but showed a strong positive correlation with the ratings in the Croatian, Hungarian, Italian, Norwegian, and Swedish databases. Ratings in the two English databases also strongly correlated with each other.

# Discussion

In accordance with previous studies, significant correlations were encountered between English and other languages (Blomberg & Öberg, 2015) and between two English databases (Bird et al., 2001). The cases where no significant results were obtained may be explained by the small number of words entered in the correlation or by the mean age of participants, which is higher in the study of Bird et al. (2001) than in the other studies. The results suggest that English imageability ratings may be used in other languages, although more accurate results may be obtained when collecting scores for each individual language. These results may be revised, for example, by correlating ratings of the same words across groups of speakers of different languages matched for age and education.

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**Table 1 Summary of Spearman correlations**

| | | Number of common words | Correlation | |
|---|---|---|---|---|
| **List 1** | **List 2** | | *rho* | *P* |
| English_Bird | English_Cortese | 467 | 0.68 | 2.2e-16* |
| Catalan | English_Bird | 20 | 0.38 | 0.09 |
| | English_Cortese | 64 | 0.61 | 5.828e-08* |
| Croatian | English_Bird | 100 | 0.70 | 2.242e-14* |
| | English_Cortese | 162 | 0.82 | 2.2e-16* |
| Hungarian | English_Bird | 24 | 0.71 | 1.05e-04* |
| | English_Cortese | 73 | 0.89 | 5.53e-26* |
| Italian | English_Bird | 111 | 0.86 | 2.2e-16* |
| | English_Cortese | 139 | 0.67 | 2.2e-16* |
| Norwegian | English_Bird | 133 | 0.62 | 3.16e.08* |
| | English_Cortese | 251 | 0.65 | 2.2e-16* |
| Serbian | English_Bird | 15 | 0.1 | 0.79 |
| | English_Cortese | 31 | 0.50 | 0.003* |
| Spanish | English_Bird | 45 | 0.59 | 2.26e-05* |
| | English_Cortese | 102 | 0.57 | 3.219e-10* |
| Swedish | English_Bird | 27 | 0.73 | 1.224e-05* |
| | English_Cortese | 75 | 0.74 | 2.265e-14* |
| Turkish | English_Bird | 31 | 0.31 | 0.08 |
| | English_Cortese | 65 | 0.62 | 3.16e-08* |

Significant correlations at $p < 0.05$ are indicated with an asterisk.

# Differences in verb and noun comprehension in aphasia

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# Introduction

There is growing evidence that verbs are more difficult to processes than nouns (Cappa & Perani, 2002) and that verb retrieval is more commonly affected in aphasia compared to nouns (Jonkers & Bastiaanse, 1998). However, existing observations are largely based on naming and semantic judgment tasks. We investigate whether this processing difficulty is modality general. In this study for the first time we directly compare difficulty of comprehension of verbs versus nouns in Russian in individuals with and without aphasia using a novel instrument – a single-word comprehension test presented on a tablet.

# Methods

## *Participants*

Thirty individuals with aphasia due to left hemisphere stroke, trauma and neuroinfection (19 men, mean age: 53; month post onset: 23.9±25.2) and 14 right-handed individuals without neurological and psychiatric disorders (7 men, mean age 45.2) participated in the study. Among patients with aphasia were 20 non-fluent and 10 fluent, their mean score on Quantitative Assessment of Speech in Aphasia (Tsvetkova, Akhutina, Pylaeva, 1981): 162.9±79.1, which corresponds to moderately severe aphasia. All participants were native speakers of Russian.

## *Stimuli and tasks*

In the single-word comprehension task participants were required to match a spoken word to one of the four images in a visual array. Verbal and visual stimuli for two subtests were taken from the databases «Verb and action: stimuli database» (Akinina et al., 2015) and «Noun and object: stimuli database» (Akinina et al., 2014). First, the stimuli were selected by norming an extended version of the tests (66 verbs and 67 nouns) on 45 participants with aphasia and 30 healthy individuals. Trials in which more than two healthy individuals made an error and those which were answered correctly by all individuals with aphasia were excluded.
The final set of 30 nouns and 30 verbs were matched on relevant psychometric properties: name agreement, subjective and objective visual complexity, familiarity, age of acquisition, imageability, image agreement, frequency, length. The task was then programmed on a tablet Samsung SM-T525 with operating system Android 4.4.2. Participants were required to match an aurally presented word to one of the four pictures in the corners of the screen (target and three distractors: semantic, phonological and irrelevant) by tapping the relevant picture with their non-dominant left hand. Audio stimuli for the task were recorded in an audio recording studio and presented simultaneously with the visual stimuli. Individuals' answers and reaction times were recorded automatically. See Figure 1 for an example of visual stimulus.

# Results

The proportion of correct answers in individuals with aphasia (IWA) (verb subtest: 0.8±0.2; noun subtest: 0.85±0.19) was significantly smaller than those in the control group of non-brain-damaged participants (NBD) (verb subtest: 0.98±0.02; noun subtest: 0.99±0.02) - for both subtests $p < .001$. At the same time, the reaction times in IWA (verb subtest: 3946±2221 ms; noun subtest: 2959±1586 ms) were significantly higher than in NBD (verb subtest: 1889±221 ms; noun subtest: 1519±138 ms) - for both subtests $p < .001$.

In NBD the reaction times for the verb subtest were higher than for the noun subtest ($p = .001$), although there was no difference in the proportion of correct answers for the two subtests ($p = .096$). IWA demonstrated significant differences between the two subtests in both proportion of correct answers ($p < .001$) and reaction times ($p = .005$). Twelve IWA who had minimal nonsignificant difference in the proportion of correct answers between the subtests also had significantly higher reaction times in the verb subtest ($p = .002$).

There was no significant difference between individuals with fluent and non-fluent aphasia neither in reaction times (nouns: $p = .9$; verbs: $p = .8$) nor in the proportion of correct answers (nouns: $p = .7$; verbs: $p = .6$). The scores on Quantitative Assessment of Speech in Aphasia were significantly correlated with the individuals' reaction times (for both subtests: $r = .6$, $p < .001$) and the proportion of correct answers (for both subtests: $r = .7$, $p < .001$).

# Discussion

Overall, the study demonstrated the relative difficulty of verb processing in a comprehension task. IWA made more mistakes in the verb comprehension subtest and both groups had greater reaction times in this subtest, which confirms that the verb comprehension task was more difficult than the noun one. This is also supported by the fact that significantly longer reaction times in the verb subtest were observed even in IWA who completed both subtests on the same level.

Obtained results support the hypothesis that verb processing difficulties are modality-general. This is in line with the fact that verb is a more complex linguistic unit than a noun. It implies more complex structural information, such as the properties and the number of arguments which should be reflected in the syntactic structure of a sentence (Cappa & Perani, 2002). Potentially, the verb's complex nature hinders its processing even in a task that does not necessarily require that information to be fully and correctly processed (such as single-word comprehension).

Significant differences in performance between individuals with and without aphasia indicate that the subtests validly index single word comprehension difficulties and that they can be used for the assessment of language deficits in individuals with aphasia. The observed difficulties of verb processing emphasize that it is important to access not only noun comprehension as it may result in underestimating of the full range of the disorder. Additionally, tracking reaction times allows to detect even subtle comprehension deficits and residual difficulties in language processing.

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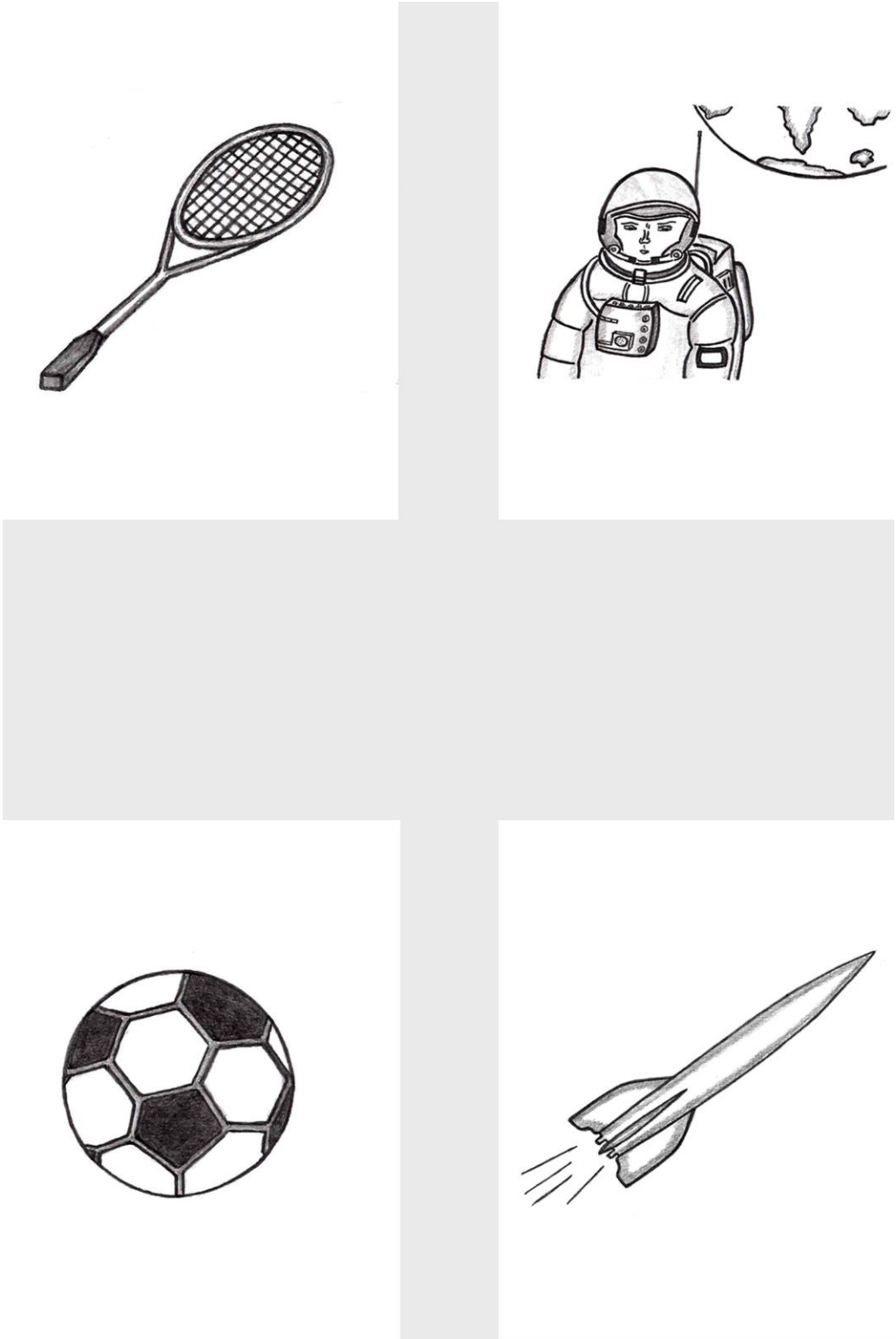
Figure 1. The screen with the visual stimuli of the noun subtest as they were seen by participants of the study. R*aketa* (‘a rocket’) – *raketka* (‘a racket’) – *kosmonavt* (‘an astronaut’) – *myach* (‘a ball’)



# Foundations of narrative coherence in aphasia – examining the role of time reference and evaluative irrealis

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## Introduction

Assessment of the coherence of discourse produced by people who have aphasia provides one window into their communicative functionality (Olness & Ulatowska, 2011). Overall coherence can be modeled as a coalescence of two key aspects of coherence: referential coherence, i.e. coherence of reference to person, action, place and time; and evaluative coherence, i.e. coherence of prominence assignment on selected propositions, to express the narrator's attitude, opinion or emotion regarding the narrated event (Olness & Ulatowska, In press). This case series presentation examines the content expressed through specific intra-textual linguistic forms in discourse produced by people with aphasia, in contribution to referential and evaluative coherence.

Discourse organization, and thus the nature of discourse coherence, varies by discourse genre (Longacre, 1996). The narrative discourse genre in particular is the focus of the current study, motivated by the ubiquity of personal stories as embedded in everyday conversation (Norrick, 2000). Referential coherence of narratives centers on expression of a temporal-causal event line set in past time and punctiliar in aspect, which is set against background content expressed in stative and progressive aspect (Longacre, 1996). Forms used to express time reference may include tense and aspect morphology, and temporal adverbials. Evaluative coherence of narratives, in contrast, is thought to center on expression of irrealis content (Labov, 1997), expressed through forms such as negative morphology and modals, in conjunction with content intensification expressed through use of other evaluative devices (Labov 1972), such as repetition and direct speech.

## Methods

### *Participants*

Five participants with aphasia were selected to represent a variety of aphasia typologies and degrees of aphasia severity. Aphasia type and aphasia severity of the cases included: mild, resolved conduction aphasia exhibiting paragrammatisms; moderate to moderate-severe non-fluent aphasia of the Broca's type; and mild to moderate fluent aphasia of the Wernicke's and anomic types.

### *Procedure*

Participants were asked to tell narratives in response to three single pictures and two picture sequences, following a protocol described in Olness (2006). Participants also told personal stories on two personally salient themes specified by an interviewer within a semi-structured interview format: a personal story of

a frightening experience and a story of meeting a spouse or significant other (Olness & Ulatowska, In press).

### *Analysis*

Lexical and morphological forms used to express time reference and irrealis were identified in each narrative sample, as representative expressions of key referential and evaluative content respectively within the narrative genre. The content expressed by these forms in each narrative sample was qualitatively assessed for its coherence, following a procedure described in Olness and Englebretson (2011).

## Results

Narratives produced in response to pictures and picture sequences included forms produced in support of referential coherence, but no forms in support of evaluative coherence. Personal narratives included forms produced in support of both referential coherence and evaluative coherence.

Time reference in narratives of participants with both fluent and non-fluent aphasia types was coherently expressed through sequential concatenation of propositions on the temporal-causal event line. Aspect was expressed by lexical means (e.g. punctiliar verb content, temporal adverbials) and by punctuated use of direct speech in the participants with non-fluent aphasia. Aspect was expressed by both lexical and morphological means in the participants with fluent aphasia, and included revisions consistent with form error types typically associated with the participants' respective aphasia typologies. Revisions, when they occurred, converged ultimately on successful time reference.

Irrealis content in the form of negative morphology was present in the personal narratives of all participants. Content expressed through these negative forms was often expressed in combination with other evaluative devices, such as repetition and direct speech.

Prosodic patterns suggest that repetition of referential forms was often used as a means of form revision, rather than as a means of emphasis of content. In contrast, prosodic patterns suggest that repetition of evaluative forms was often used as a means of emphasis of content rather than as a means of form revision.

## Discussion

Findings are consistent with the notion that narrators with aphasia actively develop both referential and evaluative coherence in their stories (Olness & Ulatowska, In press). However, forms that express evaluative content appeared to be more easily produced by speakers with aphasia in this sample than were forms that express referential content, as reflected in the prosody of repeated forms. This finding aligns with suggestions in the literature that evaluative expression may be relatively preserved as compared with referential expression among speakers who have aphasia (Nespoulous, Code, Virbel, & Lecours, 1998). Personal narrative samples may be more effective than picture-elicited narratives samples in exhibiting how people with aphasia develop both sub-types of coherence (referential and

evaluative), thus reinforcing the ecological validity of personal narrative sampling in studies of discourse coherence. Findings of the current study are limited in that they consider only intra-textual contributions to narrative coherence, although this particular focus may augment our understanding of the relationship between lexicon/morphology and discourse organization in speakers who have aphasia. Results hold implications for the development of lines of research that examine the discourse coherence and communicative functionality of people who have aphasia.

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# Model-Oriented Therapy of Graphematic Paraphasias and Neologisms

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## Introduction

For patients with severe acquired dysgraphia due to an impairment of the graphemic output lexicon and/ or the graphemic buffer, the effectiveness of an Anagram and Copy Treatment (ACT) has been proven by several clinical studies (e.g. Beeson, 1999; Beeson, Hirsch, & Rewega, 2002; Harris, Olson, & Humphreys, 2012). In contrast, the present study was designed to examine treatment outcomes in response to ACT for an individual with only a mild form of dysgraphia. The aim of the study was to provide first evidence of whether an adaption of the ACT proves both possible and valuable as a treatment method for an exemplary patient with mild dysgraphia. In line with previous research, we assumed that a successful application of ACT to this patient would lead to a reduction of graphematic paraphasias and neologisms (e.g. Harris, Olson, & Humphreys, 2012) in the logogen route of written naming.

## Methods

The ACT was conducted with a 41 year-old right-handed woman who experienced a left hemispheric stroke four years prior to participating in the study. Main aspects of ACT include the arrangement of individual graphemes and copying of target words in three steps as well as the use of a fixed hierarchy of help.

The study used a pre-post design with baseline and follow-up. Pretest I consisted of the examination of all written language routes following the logogen model with the German test "Lexikon Modellorientiert" (LeMo; De Bleser, Cholewa, Stadie, & Tabatabaie, 2004) while pretest II, executed 13 days after pretest I, contained a repeated execution of one LeMo subtest (31, "Written Naming") as well as a testing of the 18 therapy items (i.e. trained items) and the 18 untrained items. Following the pretesting phase, the patient received 12 therapy sessions à 45 minutes. The 18 therapy items were monosyllabic German words referring to real objects. Treatment outcomes were measured by means of two posttests. Posttest I included a repetition of LeMo subtests and repeated testing of trained and untrained items. The follow-up testing, posttest II, was conducted 42 days after finishing ACT and consisted of LeMo subtest 31 and an evaluation of trained and untrained items.

## Results & Conclusions

The participant responded positively to ACT. Significant improvements of especially LeMo subtest "Written Naming" from pretest I to follow-up testing could be observed ($p < 0.1$, Wilcoxon Signed Rank Test, one-tailed). Additionally, graphematic paraphasias and neologisms reduced significantly for both

trained and untrained items (see Fig. 1), pointing towards general effects of strengthening of the graphemic buffer as well as a possible strengthening of graphematic representations in the graphemic output lexicon. Results remained stable over a five-week follow-up period.

Results confirm that ACT can lead to significant and lasting improvement in written performance of an individual with a mild form of dysgraphia and therefore suggest that the ACT is a useful therapy method for this clinically relevant patient group.

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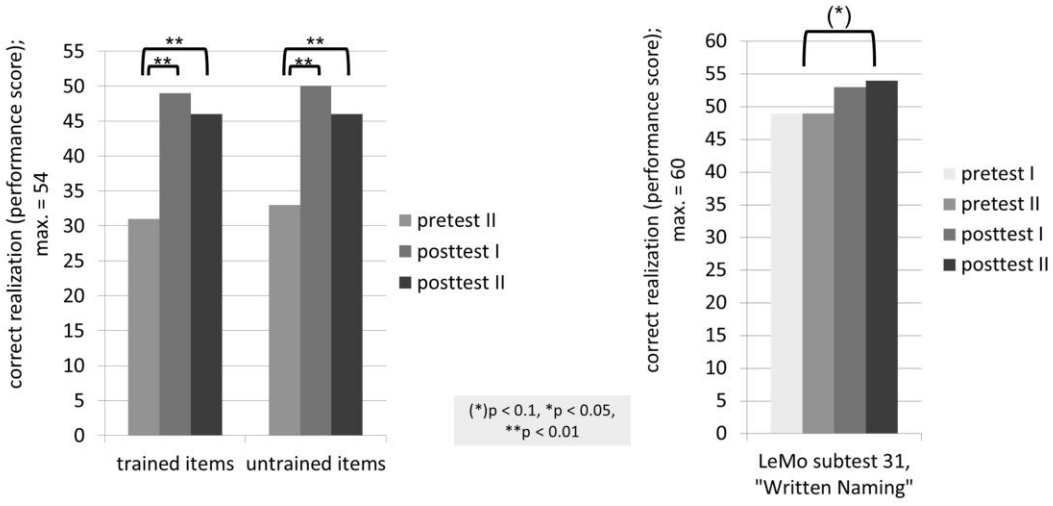


**Fig. 1:** Results of the patient in trained/ untrained items and LeMo subtest 31, "Written Naming"

# Electrical stimulation of the brain (tDCS) as a therapeutic tool in the treatment of Aphasia

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## Introduction

For mankind electricity has always been a source of fascination. As early as 43 AD, the Romans started to experiment with torpedo fish to treat headaches. With the invention of the Leyden jar in 1744, a way was found to store electricity and to use it at any given time. Since then, electricity has found its way in a variety of medical treatment protocols. In the middle of the 20th century, the first brain stimulations were performed on animals. These experiments showed that intracortical electrical stimulation may modulate behaviour and affect (Coffman, Clark, & Parasuraman, 2014). After these experiments, a device was created to stimulate the brain transcranially by means of Direct Current Stimulation (tDCS). This device is capable of sending a constant current of several mA through the skull and through the brain. It was first used in the treatment of depression and affective disorders but it was not until 2000 that the research group of Nitsche and Paulus in Gottingen created interest in tDCS as a modulator of human brain excitability (Coffman et al., 2014; Nitsche & Paulus, 2000). Their research proved that tDCS modulates the excitability of the motor neurons, in a direction-specific way. Anodal tDCS increased excitation while cathodal tDCS decreased excitation (Nitsche & Paulus, 2000). It has been amply demonstrated that tDCS applied in healthy populations not only modulates motor function, but also memory, attention, reaction times, language, and speech (Coffman et al., 2014). However, the literature on tDCS used in patient groups is with respect to its findings still very diverse and divided.

## Methods

An in-depth review was conducted to examine the validity of tDCS as a therapeutic tool in the treatment of aphasia. The most commonly used parameters were studied to extract guidelines for future research.

## Results

### *Demographics*

A total of 237 cases (150 male, 79 female, 8 unknown) from 20 different studies were included in this study, extracted from Elsner, Kugler, Pohl, and Mehrholz (2013) and Sandars, Cloutman, and Woollams (2016). Most of the patients presented with non-fluent aphasia (67%), 17% with fluent aphasia, and for 16% no data was available. Of the non-fluent aphasia types, 24% were typologically consistent with Broca-aphasia and 23% with global/mixed aphasia. Only 5% was reported to have a transcortical aphasia (1% mixed, 4% motor), and in 48% of the cases the type of non-fluent aphasia was not specified. Of the fluent aphasias, 27% was anomic, 7% presented with conduction aphasia, 5% with Wernicke, and 3% with transcortical sensory aphasia. In 58% of the cases the type of fluent aphasia was not further specified. All of the studies were conducted in the chronic phase (2 unknown) and the severity of the

aphasia was in 80% of the cases not mentioned. In 10% of the cases aphasia severity was moderate, 5% presented with severe aphasia, and 5% with a mild form of aphasia.

### *Therapy and outcome measures*

Most of the studies (n=14) investigated the accuracy and the reaction times in naming paradigms but did not take functional communication into consideration. Three of the remaining studies used conversation therapy, one MIT, one focussed on language comprehension, and one used traditional therapy. The frequency of the therapy was strongly dependent on the frequency with which tDCS was administered.

### *Stimulation parameters*

There is no consensus yet about the optimal stimulation parameters. Some studies administer tDCS during therapy (online) while others separate both treatments (offline). There is a high variability in electrode placement, although most studies choose to stimulate the left frontal regions anodally, irrespectively of lesion site. Current intensity is usually between 1 and 2mA, which has been proven to reach the cortex in cerebral stimulation. Almost all studies used multiple stimulations, ranging between 3 to 20 days. Only a handful of studies (n = 3) included a follow-up longer than one month after the therapy to investigate the long-term effects.

## Discussion

### *Demographics, therapy, and outcome measures*

There is a clear bias in the literature towards patients with **chronic non-fluent aphasia** with a focus on naming therapy. Therapy was rarely adjusted to the type of aphasia and severity of aphasia was seldomly taken into account. In addition, stimulation parameters were often kept constant throughout a heterogeneous study group, making comparisons methodologically difficult and even unreliable.

### *Stimulation parameters*

Since long-term effects of tDCS are probably due to LTP- and LTD-like plasticity effects (meaning: caused by repetitive simultaneous firing of groups of neurons) and since tDCS in itself is not capable of generating action potentials, it is likely that the combination of tDCS and therapy (online tDCS) is much more effective than only tDCS (offline tDCS). The therapy is responsible for recruiting the targeted groups of neurons, while tDCS facilitates this recruitment making long-term plasticity effects possible. Placement of the electrodes is essential in order to target the neurons will be facilitated and/or inhibited. In general, for cortical stimulation the area under the anode is excited, while the area under the cathode is inhibited. Researchers can use a setup in which two electrodes are positioned on the head (exciting one area, inhibiting the other) or with an extracephalic electrode on the shoulder, arm, or cheek. Some studies which used fMRI to determine ideal electrode placement demonstrated that stimulation of perilesional areas that are still active is effective and a correlation was found between the distance between the electrodes and the perilesional area and the outcome (Baker, Rorden, & Fridriksson, 2010; Fridriksson, Richardson, Baker, & Rorden, 2011). Studies in healthy populations have also shown that the cerebellar stimulation can have a positive effect on language functions (Boehringer, Macher, Dukart, Villringer, & Pleger, 2013; Macher, Bohringer, Villringer, & Pleger, 2014; Pope & Miall, 2012), making the cerebellum an interesting target in patients with little perilesional activity or when the distance between the skull and the perilesional activity is large.

Related to electrode placement, it is not yet clear which type of stimulation on which hemisphere is the most effective. Usually, one active condition is compared to a sham condition (placebo tDCS) without testing other setups. Both anodal stimulation of the affected hemisphere and cathodal stimulation of the contralateral unaffected hemisphere might be effective, as has been shown by TMS. However, a lot of studies focus on anodal frontal stimulation (Sandars et al., 2016). More research is needed to determine the optimal stimulation side and type.
The intensity of the current ranges in the studies between 1 and 2mA. In left prefrontal cortex stimulation an effect of current intensity on verbal fluency has been shown (Iyer et al., 2005). However, safety parameters have to be taken into account. In general 1,5 – 2mA is an appropriate current to actively stimulate the cortex of the cerebrum with tDCS. Pads are generally 5X5 cm resulting in a current density of 0,08mA/$cm^2$.
There is evidence that daily stimulation is more effective than weekly or every other day stimulation (Alonzo, Brassil, Taylor, Martin, & Loo, 2012; Boggio et al., 2007), and that the progression made in the second week of stimulation is less than in the first week (Lindenberg, Zhu, & Schlaug, 2012). However, since daily stimulation is not always feasible in practice, more research is needed to determine the optimal frequency attainable in practice. In addition, longitudinal follow-up data are needed to investigate the long-term effect of tDCS.

# Conclusion

In conclusion, despite the lack of a consensus in the aphasia literature, evidence from other research areas such as neuropsychiatric disorders (Brunoni et al., 2012) and other neurological diseases (Flöel, 2014) suggests that tDCS is a useful and beneficial strategy in aphasia rehabilitation provided that a number of parameters are taken into account. Every patient should be treated individually to determine the optimal approach in aphasia therapy, outcome measures, and tDCS parameters. Important factors are aphasia type, lesion location, perilesional activity, and lesion size. fMRI might be a useful approach to assess the impact of different types of tDCS on brain activity. Recent evidence also suggests that the cerebellum might be an interesting target for stimulation to improve language functions (van Dun, Manto, & Mariën, 2016).

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# The public awareness of aphasia in Serbia and Montenegro

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## Introduction

The public awareness of aphasia is universally low compared to other related conditions, but highly variable between countries according to the international studies that have been completed. There appears to be a relationship between, on the one hand, the levels of awareness of a condition and on the other, the services provided and the support for research available for a health condition. But there has been no research into the public awareness of aphasia in Serbia and Montenegro, although there have been published awareness surveys in many other countries, including the Balkan countries of Croatia and Slovenia.

## Methods & Procedures

Standardised surveys were conducted in Serbia (N=400) and Montenegro (N=500) using an adapted version of the awareness of aphasia survey questionnaire developed by Code et al. (2001). Respondents were asked whether they have ever heard of aphasia, and for those who said they had, we tested their knowledge by asking them questions about the disorder. Surveys also sought information on respondents' gender, age, occupation and education.

## Results

We surveyed 900 respondents altogether. In Serbia 12% of respondents said they had heard of aphasia, while in Montenegro 11% said that they had (11.44% overall). However, just 4% (Serbia) and 3.2% (Montenegro) of respondents had a basic knowledge of aphasia (3.55% overall). Age, gender and occupation interacted significantly with levels of awareness.

## Discussion

The levels of public awareness of aphasia in Serbia and Montenegro are similar to levels of other countries, including other Balkan countries like Croatia and Slovenia. Our results confirm that awareness of aphasia is significantly associated with age, gender and educational levels. . It also confirmed previous findings that for those who have some knowledge of aphasia, this knowledge is gained through personal or professional interaction with people with aphasia or through the media. The data provides a basis for the delivery of an awareness raising campaign in Balkan countries to reduce social stigmatization, improve community access, provide improved understanding by all sections of the community and encourage health and social care providers to expand services and research funders to recognize the importance of research into the effectiveness of rehabilitation and reintegration programmes for aphasic people.

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# She knows X, she thinks X: Aphasic comprehension of factive and non-factive clausal embedding

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## Introduction

Successful communication requires speakers to understand which statements are considered true, and which not, and to share these varying levels of certainties with each other. *Factivity*, i.e. the degree to which a proposition is presupposed to be true, is therefore a crucial feature of human language. It can be driven by verb use. In a sentence with factive embedding, e.g. $_S$[He *knows* $_{S'}$[that it is warm outside]], the matrix verb *knows* implies that the content of the embedded clause is true. In non-factive embedding, e.g. $_S$[He *thinks* $_{S'}$[that it is warm outside]], there is no such implication. The latter sentence can be true even if temperatures are below zero.

Investigations of factivity in aphasia are concerned with tense marking, and it has been proposed that people with aphasia have particular difficulties with "non-factive" tense such as future (Yarbay Duman & Bastiaanse, 2009). Factivity as expressed through verb phrases has received little attention in aphasia research.

Non-factive verbs (e.g., *think*) are commonly used in false belief attribution. In tasks with reduced verbal demands, Theory of Mind (ToM) appears intact even in people with severe aphasia (Apperly, Samson, Carroll, Hussain, & Humphreys, 2006; Varley & Siegal, 2000). Still, we predicted that non-factive embedding would be more difficult for people with aphasia as they require processing of a cross-clausal relationship to modify the "default" factivity value of the embedded clause (e.g., "it is warm outside").

We investigated comprehension of verb-driven factive and non-factive clause embedding in speakers with aphasia, using a newly designed sentence-picture matching task.

## Methods

### *Participants*

We recruited 20 people with aphasia (PWA) of various types and severity, from mild-moderate anomia to severe syntactic disorder. We also recruited 30 age equivalent non-brain-damaged controls (NBD).

### *Materials and procedure*

Our sentence-picture matching task tested four different constructions: "NP knows that X", "NP thinks that X", "It is clear to NP that X", and one counter-factive construction, "It only seems to NP that X". Embedded clauses made exclusive use of copula verbs (e.g. "it is warm outside") in order to keep them

morphologically simple. Each sentence was presented with a set of three drawn pictures. Pictures showed a situation and an "experiencer". For instance, for the stimulus sentence "He knows that it is warm outside", pictures showed a man indoors getting ready to go outside. They varied in the situation (it can be summer or winter outside) and the state of the experiencer (the man can wear summer or winter clothes).

The experimenter read each sentence to the participant, who had to point at the matching picture. For "The man knows that it is warm outside", the target was the picture in which the man wore light clothing and it was sunny outside. For the non-factive "The man thinks that it is warm outside" the only correct matching option presented showed a man in summer clothing heading into the cold. For counter-factive sentences, the correct response showed the experiencer having a false perspective of the situation. For instance, the matching picture for "It only seems to the woman that the man is tall" showed a woman looking at an apparently "tall" man standing behind a wall, not seeing that he is standing on a stool.

# Results

In relation to NBD controls, PWA performed only slightly worse in factive, worse in counter-factive and much worse in non-factive trials. In PWA, overall performance and performance in non-factive trials was predicted by performance on the Test of Reception of Grammar (TROG-2). However, deviations from control performance were much bigger on the TROG-2, suggesting that provided with morphologically simple structures in the embedded clause, PWA are able to understand non-factive embedding even if they have moderate-severe syntactic disorder (up to 5 standard deviations below the control mean on the TROG-2).

# Discussion

Our results show a comprehension disadvantage in PWA with regards to factivity in clause embedding, most pronounced in sentences with non-factive embedding. Given evidence for intact non-verbal ToM in aphasia, we suspect that the issue is syntactic rather than on the level of social cognition.

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# APPEAR: Aphasia Practice

# Pilot study: an evaluation as an associative investigation

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## Introduction

The implementation of ICF requires the alignment of diagnostics, therapy and evaluation of participation in personal, occupational and social life (activity and participation). Providers of healthcare demand an alignment of ICF. The same applies to the rehabilitation of aphasia – loss of speech after completed language acquisition mostly due to a stroke. The participation of aphasic patients is limited in all contexts of life when verbal abilities such as understanding, speaking, having a conversation, reading and writing are demanded. So far, however, there has been no data collected on the actual state of ICF-orientated Aphasia Practice in the German-speaking world. Publications on institutional Good Practice do not exist. Therefore, the objective of the study was to collect data on the actual state of ICF-orientated Aphasia Practice.

## Methods

APPEAR Aphasia answers the following questions:

1. To which extent is Aphasia Practice context-orientated in terms of ICF?
   The objective was to collect data in order to assess and judge the actual state of diagnostics, therapy and evaluation.
2. What concepts for a more dominant alignment of ICF exist in speech and language therapy practice?
   Parameters of everyday therapy and contents that allow a reference to participation-orientated and vital situations during diagnostics, therapy and consulting were of interest. This applies also to therapeutic success.

Proceedings:

We interviewed heads of speech and language therapists (N=45) in rehabilitations clinics that treat patients with post-acute and not geriatric aphasia in Germany, Austria and the German part of Switzerland (CH: n = 14, A: n = 19, D: n = 12). The project was run in cooperation with two partner universities of Applied Sciences (SHLR Rorschach/JOANNEUM Graz).
The study has been divided into three steps:

- Online survey with heads of speech and language therapists in rehabilitation clinics (November 2012 - January 2013)
- Conference with experts and guided one-on-one interviews with heads of speech and language therapists in rehabilitation clinics and association representatives (May 2015)
- Validation: evaluation of the survey by means of interviews and the written votings from the conference with experts

Two independent evaluators selected, matched and summarized the main statements by qualitative content analysis.

# Results

The results show that if stationary therapy organized a network of aftercare, more alignment in terms of ICF would emerge. Ambulant clinical services would be part of this network. The implementation requires that conceptual gaps be filled such as assessment tools, therapeutic procedures and instruments of Outcome-Measurement in terms of quality of life orientated speech and language therapy. New assessment tools that involve primary interlocutors of aphasic patients have to be developed. Parameters that allow more flexible and vital planning are needed; Basic approaches are deployed in the SMO-Clinic in Vorarlberg (A).

# Discussion

The results show that the idea of ICF in speech and language therapy is present in daily routines of institutions in all three countries (a bit more in CH and D as in A). This concerns in particular goals that are targeted inter-professionally but also in consent with aggrieved parties. However, there is still a need for development. Currently, it is difficult to find an ICF-compatible approach due to the lack of ICF-compatible diagnostics, therapy and evaluation measurements. These conceptual gaps in the work area of speech and language therapy need to be closed any time soon.

When making therapeutic decisions and revision, everyday dialogues and quality of life regarding speech and language should be explicitly taken into account. This does not imply that working in a strict linguistic manner is considered inappropriate during the acute phase.

However, stationary treatment will become inefficient if patient transfers are not successful or the required frequency is not adhered. A stagnation at the interface of stationary to ambulant treatment is unsatisfactory for all parties affected. Therefore, a network of post-rehabilitation support is required to allow more context.

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# Early recovery profiles of language and executive functions in blingual persons following brain injury

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## Introduction

There is a burgeoning body of research on the impact of very early intervention in aphasia and related disorders (Laska et al., 2008;Godecke et al., 2012). The process of recovery in the acute phase is important to understand as it will impact the choice, timing, and nature of such therapy. This is particularly the case for bilingual persons, whose recovery patterns are distinct from those of monolinguals and often create a challenge for the monolingual clinician. An improved understanding of such underlying linguistic and cognitive processes may enhance assessment and treatment. Prior research suggests that the choice of technique, as well as the language in which therapy is conducted, may very well depend on the accurate assessment of executive functions which is typically complicated by a number of variables including motor aspects (including hemiplegia ) , educational and cultural dimensions (Miyake et al 2000; Keil and Kaszniak,2000 ).

There is a need to develop a simple, effective battery which is able to differentiate etiologies, is sensitive to recovery processes, and in a multicultural and multilingual context, is able to distinguish normal from pathological profiles.

This study was designed to explore possible relationships between linguistic and non-linguistic factors that may contribute to the recovery profiles in three bilingual clinical groups with cognitive and communication disorders observed within the first 12 weeks post injury

## Methods

A multivalent comparison study with a longitudinal component was conducted at two acute rehabilitation centres in the multilingual context of South Africa . A sample of 29 bilingual, second language English speaking participants (19 with a cerebral vascular accident (CVA) and 10 with a traumatic brain injury (TBI)) were assessed at two time periods within the first 12 weeks post injury. They were assessed using an adapted version of the Comprehensive Aphasia Test (CAT) and a nonverbal EF battery. The nonverbal battery comprised tasks to assess updating (n-back task), mental shifting (number-letter task; Wisconsin Card Sorting test), and inhibition (Victoria Stroop; Tower of Hanoi). A control group of 19 neurologically intact bilingual, second language English speakers who were matched according to age and education level, were assessed employing the same battery. The control group completed an initial assessment and then were reassessed six weeks later.

## Results

The CAT was found to be a suitable assessment measure when assessing bilingual, second language English speakers in the South African context. A between- group analysis identified statistically significant differences between etiologies for language assessment as well as the EF assessment, and was able to differentiate normal from pathological individuals. While most of the test battery was found to be suitable for the participants, the Tower of Hanoi and the number-letter task were deemed

inappropriate for the population and the cultural context. A within- group analysis determined that there were unique profiles of language and EF skills according to etiology and that different profiles of change emerged across each etiology for both language and EF subtests. There were also distinct relationships between language skills and EF skills for each etiology across the time period (see table) which provided insight into the interactions between language and EF during the acute phase of recovery.

# Discussion

This results confirm prior research on recovery processses in language across the three etiologies but also highlight changes in excutive functioning which may offer some explanations for differential recovery profiles.Despite testing in the second language of the particpants ,the streamlined battery proved clinically sensitive in the acute phase .The results highlighted that inhibition may be a preserved bilingual advantage in participants with a right CVA or TBI. However, in contrast to some of prior reserach in bilingual chronic patients with aphasia (Penn et al , 2010) deficits in inhibition were observed to be persistent in the group with left CVA across the time period of testing. It has been hypothesised that deficits in inhibition in the bilingual persons with a left CVA may cause the weaker language premorbidly to be more at risk and that processes such as selective recovery, pathological switching or mixing may link to this aspect (Green & Abutalebi, 2008). Such evidence may support the decision making process with regard to the nature of therapy in the acute phase and the language for therapy. Appropriate language assessment and treatment in the acute phase for bilingual persons ideally needs to be framed by a detailed understanding of recovery patterns, what is driving that pattern, and which cognitive deficits are contributing to the language behaviour.

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Table 1.

*Correlations between CAT subtests and EF subtests at 6 and 12 weeks post injury according to etiology employing Pearson analysis (r).*

| | **Left CVA** (n=10) | | | **Right CVA** (n=9) | | | **TBI** (n=10) | | |
|---|---|---|---|---|---|---|---|---|---|
| | N-Back updating | VicStroop inhibition | WCST shifting | N-Back updating | VicStroop inhibition | WCST shifting | N-Back updating | VicStroop inhibition | WCST shifting |
| **CAT subtests** | | | | | | | | | |
| **Language Subtests** | | | | | | | | | |
| Comprehension of spoken language | 0.62 | 0.43 | 0.30 | 0.66* | 0.49 | 0.57 | 0.45 | 0.51 | 0.66* |
| Comprehension of written language | 0.62 | 0.43 | 0.43 | 0.75* | 0.74* | 0.66 | 0.67* | 0.59 | 0.85** |
| Repetition | 0.39 | 0.61 | -0.23 | 0.09 | 0.12 | -0.41 | 0.09 | 0.18 | 0.26 |
| Naming | 0.52 | 0.57 | 0.22 | 0.67* | 0.60 | 0.48 | 0.53 | 0.40 | 0.78** |
| Reading | 0.32 | 0.76* | -0.07 | 0.36 | 0.49 | 0.65 | 0.45 | 0.46 | 0.69* |
| Writing | 0.24 | 0.63* | 0.37 | 0.83** | 0.79* | 0.55 | 0.56 | 0.45 | 0.76* |
| Spoken Picture Description | 0.64* | 0.57 | 0.25 | 0.41 | 0.55 | 0.74* | -0.08 | 0.42 | 0.44 |
| Written Picture Description | 0.50 | 0.21 | 0.47 | 0.49 | 0.36 | 0.37 | 0.35 | 0.66* | 0.79** |
| **Cognitive Subtests** | | | | | | | | | |
| Memory | 0.64* | 0.41 | 0.69* | 0.65 | 0.64 | 0.71* | 0.68* | 0.47 | 0.87** |
| Gesture Object Use | 0.24 | 0.20 | 0.51 | Could not be computed as variable was constant | | | 0.42 | 0.47 | 0.64* |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Arithmetic | 0.46 | 0.56 | 0.48 | 0.27 | 0.63 | 0.40 | 0.48 | 0.79** | 0.78** |
| Word Fluency | 0.51 | 0.65* | 0.16 | 0.67* | 0.61 | 0.23 | 0.32 | 0.35 | 0.73* |

*12 weeks post injury*

| | **Left CVA** (n=10) | | | **Right CVA** (n=9) | | | **TBI** (n=10) | | |
|---|---|---|---|---|---|---|---|---|---|
| | N-Back (updating) | VicStroop (inhibition) | WCST (shifting) | N-Back (updating) | VicStroop (inhibition) | WCST (shifting) | N-Back (updating) | VicStroop (inhibition) | WCST (shifting) |
| **CAT subtests** | | | | | | | | | |
| **Language Subtests** | | | | | | | | | |
| Comprehension of spoken language | 0.43 | 0.33 | 0.69* | 0.65 | 0.04 | 0.25 | 0.15 | 0.12 | 0.39 |
| Comprehension of written language | 0.64* | 0.42 | 0.67* | 0.51 | -0.03 | 0.10 | -0.05 | 0.01 | 0.34 |
| Repetition | 0.57 | 0.66* | 0.30 | 0.13 | 0.59 | 0.31 | 0.09 | 0.11 | 0.37 |
| Naming | 0.49 | 0.49 | 0.53 | 0.73* | 0.05 | 0.27 | 0.30 | 0.19 | 0.37 |
| Reading | 0.65* | 0.35 | 0.44 | 0.08 | 0.42 | -0.01 | 0.04 | 0.05 | 0.62 |
| Writing | 0.68* | 0.44 | 0.59 | 0.83** | -0.18 | 0.74* | 0.08 | 0.17 | 0.30 |
| Spoken Picture Description | 0.70* | 0.65* | 0.46 | 0.59 | 0.02 | 0.47 | -0.08 | 0.07 | 0.52 |
| Written Picture Description | 0.52 | 0.21 | 0.62 | 0.49 | 0.09 | 0.04 | -0.06 | 0.03 | 0.12 |
| **Cognitive Subtests** | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Memory | 0.73** | 0.60* | 0.62* | 0.73* | -0.18 | 0.12 | 0.24 | 0.11 | 0.24 |
| Line Bisection | 0.68* | 0.11 | 0.68* | 0.46 | -0.05 | -0.01 | -0.16 | 0.20 | 0.54 |
| Gesture Object use | 0.28 | 0.22 | 0.53 | Could not be computed as variable was constant | | | -0.09 | 0.13 | -0.53 |
| Arithmetic | 0.62* | 0.34 | 0.56 | 0.11 | -0.41 | 0.38 | 0.34 | 0.17 | 0.21 |
| Word Fluency | 0.43 | 0.22 | 0.43 | 0.84** | -0.23 | 0.42 | 0.17 | -0.02 | 0.27 |

# Behind executive functions - the role of linguistic components in word generation tasks.

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## Introduction

Verbal fluency (or word generation) tasks are widely used in cognitive psychology and are often used as an assessment of executive functions, which are subserved by the prefrontal cortex (Mitrushina et al., 2005). A number of studies suggest an involvement of attention, short-term memory, cognitive flexibility, inhibition and long-term vocabulary storage (see Mitrushina, 2005). However, as a generative naming task, verbal fluency involves language components, including word retrieval processes, a fact that is neglected in many studies (see Shao, Janse, Visser & Meyer, 2014; Whiteside et al., 2015). Responses are mostly analyzed with respect to the number of correct responses, the number of switches from one subcategory to another and the size of the clusters produced within subcategories (see Troyer, Moscovitch, Winocur, Alexander & Stuss, 1998). While some researchers have argued that there is a frontal-temporal dissociation between switching (frontal) and clustering (temporal) across fluency tasks, others have argued that the frontal-temporal dissociation pertains to phonological (frontal) vs. semantic (temporal) fluency (see Baldo, Schwartz, Wilkins & Dronkers, 2010; Stielow, 2015; Troyer et al., 1998). We assume that using verbal fluency tasks solely to test executive functions severely underestimate the word retrieval processes which are involved and essential to perform these tasks.

## Methods

### *Experiment 1*

In Experiment 1, we tested nine patients with anomia following CVA and nine healthy controls, matched to the patients in gender, age and education. We assessed the linguistic performance of the patient group using an extensive language testing battery. In addition, both groups of participants completed the Trail Making Test, the Digit Span test and the Corsi block-tapping as well as the Stroop test to assess the executive function components shifting, working memory and inhibition, respectively (see Miyake, Friedman, Emerson, Witzki, Howeter & Wager, 2000). We conducted a letter (d, n, h, s) and a semantic (sports, clothes, sweets, animals) fluency task and analyzed the performance with respect to the number of correct words, error type, switching and clustering component scores as well as lexical characteristics (word frequency and word length).

### *Experiment 2*

In Experiment 2, we tested 42 healthy young speaker and conducted the word generation tasks as described for Experiment 1. In addition, all participants completed a rhyming task and four subtests from the Test of Attentional Performance (TAP) to assess the shifting, working memory and inhibition capacities, respectively.

## Results

In Experiment 1, both letter and semantic fluency were correlated more strongly with executive functions in the group of aphasic patients compared with the group of healthy controls. Quantitative

performance measures such as number of correct words, but not qualitative performance measures such as clustering and word frequency differed between the groups. Initial results considering the language tasks showed that accuracy in picture naming was correlated with semantic fluency whereas the performance in rhyming was correlated with letter fluency.

# Discussion

We showed that letter and semantic fluency tasks draw on word retrieval processes in different ways. While semantic fluency is linked with lexical-semantic processes and also correlates with other lexical-semantic tasks like picture naming, letter fluency is linked with phonological retrieval processes and correlates with other phonological tasks like rhyming. That shows that not only executive functions, but also different linguistic components are important and needed to successfully perform semantic and letter fluency tasks. Additionally, we showed that aphasic patients generate fewer words than control speaker, but their responses did not differ in qualitative aspects such as cluster size and word frequency. As verbal fluency tasks are widely used in cognitive psychology and neuropsychological assessments in many different diseases (e.g. Alzheimer, schizophrenia, depression, Huntington's) it is important to clarify what exact executive and language components are involved in these tasks. The present study furthers this issue in verbal fluency research.

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# Investigating transfer effects after working memory training in aphasia

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## Introduction

Aphasia is frequently accompanied by working memory (WM) deficits that negatively influence spoken sentence comprehension (Novick et al., 2009) and functional communication (Frankel et al., 2007). Recent studies suggest that training WM may be beneficial for individuals with aphasia (IWA) (e.g., Murray, 2012; Salis, 2012, Zakariás et al., 2016). However, the extent of transfer (i.e., "near" and "far" transfer effects) following WM training is still not well understood. More importantly, transfer effects on functional communication and everyday memory have not yet been investigated in IWA.

To address this knowledge gap, the present ongoing study will answer two major questions: Does WM training transfer to (1) WM domains targeted by the training but measured by untrained tasks (i.e., near transfer), and (2) to spoken sentence comprehension, functional communication, and everyday memory (i.e., far transfer) in IWA?

## Methods

### *Participants*

IWA (right-handed) are included based on the following criteria: aphasia as a result of left hemisphere stroke; at least 8 months post-onset; Broca's or transcortical motor aphasia, or moderate to severe impairment in sentence comprehension together with good word comprehension based on the Aachen Aphasia Test (AAT, Huber, 1983); German as the primary language; a score of 3 items or below in a verbal WM task (Listening Span) and a score of 4 items or below in a visuo-spatial WM task (Corsi Block Tapping).

### *Design*

We will use a case-series crossover design with multiple experimental baselines (with two time points) and a 1-month follow up. Participants will practise two training tasks (two *n*-back tasks) over a period of six weeks. There will be three training sessions per week, lasting approximately 25 minutes each. Each participant will receive two 3-week blocks of training: (1) Semantic *n*-back training; and (2) Phonological *n*-back training in a random order. They will be assessed before the first training block (i.e., pretest), between the first and second training block (i.e., midtest), and after the second training block (i.e., posttest) on a number of tasks measuring language ability and WM.

### *Training tasks and outcome measures*

We designed two *n*-back tasks for the training: a phonological *n*-back task (*n*-back with spoken words) and a semantic *n*-back task (*n*-back with pictures), targeting several WM processes, namely maintaining and updating WM representations and interference control. The two tasks are adaptive, that is, the task demand is always continuously adapted according to participants' performance. Such a design has been successful in producing transfer effects in aphasia (Zakariás et al., 2016). Participants are exposed to a continuous stream of stimuli (i.e., either spoken words or pictures) and are asked to press a button when the stimulus presented is the same as the one appearing *n* trials prior to this presentation. In addition, "lures" are incorporated into the task; stimuli that are the same as the one presented *n-1* or *n+1* (but not *n*) trials before, requiring participants to resolve the conflict between the representation of the target and that of a highly familiar lure. Increase in difficulty level means advancing through three lure levels at each value of *n* (i.e., no lures, *n+1* lures only, and both *n+1* and *n-1* lures). Finally, several motivational factors will be assessed after each session to capture their effects on training performance across time.

The outcome measures will include various tasks assessing WM, interference control, spoken sentence comprehension, functional communication, and everyday memory. Outcome measures of spoken sentence comprehension (e.g., Sätze verstehen, Burchert et al., 2011), including specific syntactic structures will allow for testing the specificity of transfer effects and pointing to the exact underlying mechanisms of transfer on sentence comprehension.

Oral word reading as a non-targeted control measure will be also used to ensure that possible improvements on the outcome measures are specifically related to the WM training.

## Data analysis and expected results

Group level and individual performances on the training task will be tested using Friedman's ANOVA and Spearman correlation coefficient, respectively. Performances at pretest, midtest, and posttest on the outcome measures will be compared with McNemar's test for each participant separately, and with Wilcoxon signed rank test at the group level. Scores in the motivation questionnaire will be tested with Pearson correlation coefficient. We expect that IWA improving on the training tasks will improve also on all outcome measures, however, will not show improvement on the non-targeted control measure.

## Discussion

This study will improve our understanding of transfer effects of WM training in multiple cognitive domains and, importantly, in functional activities (cf., Webster et al., 2015) in IWA. It will also further our understanding of the relationship between WM, spoken sentence comprehension, and functional communication, and will shed light on the role of motivational factors in aphasia treatment. Finally, it will help improve the evidence-base of treatment effectiveness in aphasia (Brady et al., 2011).

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# Trialling a multilevel approach to improving discourse in Primary Progressive Aphasia: A pilot study

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# Introduction

Impairment based interventions for people with Primary Progressive Aphasia (PPA) have targeted lexical retrieval almost exclusively, demonstrating significant potential for people with PPA to learn/relearn words (Gorno-Tempini et al., 2004; Jokel et al., 2014). The ecological validity of treatment effects has, however, been questioned, with minimal documented evidence for generalised improvement of word retrieval in everyday discourse. A recent randomised controlled trial with people with post-stroke aphasia (the NARNIA Study; Whitworth, Leitão, et al., 2015) has demonstrated promising results following a novel discourse therapy, where lexical gains were seen across a range of everyday, monologic discourse genres. These were in addition to gains in sentence production and discourse features in the same discourse samples. Interpreted against Levelt's (1999) model of language production, one of the theoretical aspects of the NARNIA intervention considered to be related to its success is the dual focus on both language – words and sentences (formulation) and cognition – discourse planning (conceptualisation). As discourse draws more heavily on the cognitive processes involved in planning, memory, attention and organisational discourse structure, the simultaneous focus on both language and those cognitive processes that directly underpin language and social communication provides an opportunity to explore generalisation to everyday discourse, a novel area of investigation within the PPA literature. Given the difficulties in lexical access seen in PPA, and different profiles of cognitive difficulties emerging over time, this intervention may provide both direction and insights for intervention with this clinical population.

## *Aim*

This pilot study involving two participants with PPA aimed to evaluate the effectiveness of a multilevel discourse therapy that has been found to significantly improve word retrieval in everyday discourse in individuals with aphasia following stroke. Given both the similarities and differences between the linguistic deficits seen in PPA and post-stroke aphasia, identifying whether similar positive language outcomes would be demonstrated by individuals with PPA is of interest both theoretically and clinically.

# Methods

Two participants with PPA, a 59 year old woman with logopenic variant (involving short term working memory) and a 54 year old man with semantic variant (involving semantic memory) were recruited to the study. A prospective case-series design was used to investigate the effects of a multilevel discourse therapy on word access, sentence production, discourse structure, and quality of life. The theoretically motivated intervention targeted a range of discourse genre and focused on individualised vocabulary, topics, and events. Following principles set out in the NARNIA study (Whitworth, Leitão., et al, 2015) and adapted for the PPA population, intervention was offered twice weekly over 10 weeks (total of 20

sessions). The Curtin University Discourse Protocol (CUDP) (Whitworth, Claessen, et al., 2015) was the primary outcome measure completed pre, immediately post, and four weeks post intervention.

# Results

Both participants made significant gains in amount of overall output, light and heavy noun and verb usage, and number of information components in the body of their discourse. Most gains were maintained for both participants four weeks later. Individual patterns of performance and generalisation across word classes and contexts will be presented. Results will also be interpreted in the light of individual linguistic and cognitive difficulties relating to their PPA profiles.

# Conclusions

These preliminary findings are promising in demonstrating across language level benefits of a novel discourse intervention for people with PPA, particularly in the light of the dearth of literature reporting generalisation of therapy gains to everyday communication. The findings support a shift in focus from word level treatments to discourse in order to maximise generalisation effects and provide direction for future research. This study also provides an early platform to examine the interface between cognition and language in interventions for aphasia and related impairments.

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# Comparing the effectiveness of errorless and errorful learning in naming therapy in aphasia. What do you like to improve?

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## Introduction

In the past 15 years there has been some research work on errorless learning as a treatment method for word finding difficulties in aphasia (e.g. Abel, Schultz, Radermacher, Willmes, & Huber, 2005; Conroy, Sage, & Lambon Ralph, 2009; Fillingham, Sage, & Lambon Ralph, 2005a, 2005b, 2006; McKissock & Ward, 2007; Middleton, Schwartz, Rawson, & Garvey, 2015). All studies presumed that both errorless learning as well as the conventional errorful treatment conditions affected the same underlying functional deficits. Therefore both were expected to improve naming. But whereas some results clearly count for an advantage of errorless over errorful learning methods in the naming improvement of aphasics (e.g. McKissock & Ward, 2007), in some studies similar outcomes for both conditions were found (e.g. Conroy et al., 2009; Fillingham et al., 2005a, 2005b, 2006). The detailed impact of the treatment approaches remains unclear.

This study deals with the following novel questions: How does errorless and errorful learning methods affect naming? And when there is no naming improvement, is there no therapy impact at all? On the basis of a single case series design with a detailed background assessment of every participant it can be shown that the improvements in naming after errorless learning depend on the individual underlying functional deficits in each participant. It seems to be important to look close on other linguistic levels as well as neuropsychological competence to assume effectiveness of either therapy method.

In this study a multiple baseline cross over design with multiple reassessments is used to show how individually effective both errorless and errorful learning methods can be.

## Methods

### *Participants*

Data from seven participants is presented. All of them suffered from word finding difficulties as a major symptom of their aphasia after a brain lesion. The naming deficits aroused either from a semantic or a post-semantic deficit. To clearly categorize the basis of the word finding problems a detailed language and neuropsychological assessment was completed before the first therapy condition started. Furthermore any kinds of perceptual deficits, dyspraxia or dysarthria were excluded. All participants were at least six months post onset, so general improvements that were not due to therapy were unlikely. Finally all seven participants should not name more than 55 % of the pictures presented (the pictures were selected and used for therapy).

## *Materials*

A set of 180 colored photos were selected. These monomorphematic single words were divided into four Sets of 45 items all matched for animacy, age of acquisition, emphasis, phonemes, syllables, frequency, semantic category and individual naming of every participant (most linguistic parameters can be found in Lorenz, 2004).

## *Therapy*

This therapy study was a multiple baseline cross over design to compare errorless and errorful methods. The four picture sets were assigned to two treatment phases – the errorless and the errorful condition – in which one set was treated and the second served as control set. Therefore generalization to untreated material could be detected.

All sets were shown three times before the therapy started to ensure a stable performance. At least four follow-up-measurements (minimum 14 weeks) should illustrate long-term effects of the treatments. Most importantly after each therapy condition specific individual linguistic and neuropsychological testings were reassessed to show changes on other levels due to the therapy.

In the errorless learning condition a picture was shown on a screen and the experimenter simultaneously named the picture. The participant was asked to repeat the correct phonological word for three times. In the errorful condition also a picture was shown on a screen but the experimenter asked the participant to try to name the picture first. The experimenter gave a feedback including the correct word form and the participant was asked to repeat it twice. Every picture was shown three times a session.

In every treatment condition therapy took place once a week (with interruptions due to holidays or illness) and took 8 sessions. To eliminate effects in order, the therapy conditions were assigned randomly. Three participants started with the errorless learning method, four began with the errorful condition.

# Results

The data shows interesting effects of both kinds of therapy. While naming improvements can be found in every participant after the errorful treatment condition, in the errorless treatment only four could improve their naming. The reassessment of linguistic and neuropsychological testings after each condition showed modifications on other levels particularly after errorless therapy for all participants.

# Discussion

The results show that the errorless as well as the errorful treatment approach can both lead to improvements in word finding difficulties irrespective of the underlying functional deficit. On the whole the data replicates the findings that errorful learning methods lead to an at least slightly higher effectiveness in improving naming (Abel et al., 2005; Conroy et al., 2009; Fillingham et al., 2005a, 2005b,

2006). But unlike other studies this one has a closer look at the impact of errorless and errorful learning methods. Therefore novel data can be presented. Most interestingly improvements on other linguistic and neuropsychological levels could be found especially after the errorless condition. The data gives an insight in the working mechanisms of the therapy methods on the basis of the underlying deficits. This leads to the assumption that it´s not a question of what kind of therapy – errorless or errorful – one should use for naming therapy. It´s a question of what should be improved.

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# Generalisation following a multilevel discourse intervention: Is conversation really the gold standard?

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## Introduction

Conversational gains continue to be seen as the gold standard for demonstrating the effectiveness of our interventions in aphasia despite the elusive and variable nature of conversation, the different demands involved, and our lack of clinical tools to assess it (Carragher, Conroy, Sage, & Wilkinson, 2012; Lind, Kristoffersen, Moen, & Simonsen, 2009). In a recent prospective, single blind randomised controlled trial, the NARNIA Study (a Novel Approach to Real-life communication: Narrative Intervention in Aphasia) directly targeted a range of monologic discourse genres (procedures, recounts and expositions) and found significant improvements at the word, sentence and discourse levels in the experimental group compared to usual care controls in each of the targeted discourse genres (Whitworth, Leitão., et al, 2015). Given that conversation is considered to be comprised of these other genres (Boyle, 2011), it might be hypothesised that robust improvements in monologic discourse would generalise to conversation.

## Aim

This study compared performance on monologic discourse tasks with conversational output in eight people with aphasia who received the NARNIA intervention, analysing change both at the group and individual level, to determine whether multilevel gains in monologues were evident in conversation.

## Methods

Eight participants (five males and three females) with mild to moderate aphasia following left hemisphere stroke were involved in the study (*mean age*: 63 years 6 months; *SD*: 16 years 2 months). A range of aphasia types were included. Average time post stroke was one year nine months. Participants were medically stable, with no cognitive difficulties, presenting with their first episode of aphasia, undergoing rehabilitation, and were proficient in English prior to their stroke.

Conversational samples, along with ten samples of monologic discourse, were collected pre, post and five weeks post intervention using the Curtin University Discourse Protocol (Whitworth, Claessen, et al.,

2015), transcribed into SALT (Miller & Iglesias, 2008) and analysed on word, sentence and discourse level measures. Specifically, the study compared measures at the word level (light, heavy and mental verbs), sentence level (undetermined thematic structures, number of arguments, complex thematic embedding, omitted obligatory arguments) and discourse level (informativeness; % Correct Information Units [CIUs], Nicholas & Brookshire, 1993).

# Results

Analysis was carried out at both a group and individual level. At a group level, in contrast to the analysis of monologues where robust changes were seen across genres, no main effect of treatment was found on production of heavy verbs, $F(1.16, 6.93) = 0.83$, $p > .05$, light verbs, $F(2, 12) = 0.91$, $p > .05$ or mental verbs, $F(1.17, 6.99) = 1.21$, $p > .05$, at the single word level. Also, unlike the patterns seen in monologic discourse, at the sentence level a significant difference was found in the lower numbers of structures that had an undetermined thematic structure (UTS) (e.g. isolated phrases without verbs) ($F$ (2, 12) = 4.21, $p <0.05$) from pre to post intervention, although this difference was not evident five weeks following intervention. No other differences were seen in the sentence level measures. At the discourse level, there was no main effect of treatment on informativeness of speech, $F(2, 12) = 0.96$, $p > .05$, despite significant group differences in informativeness (and measures of discourse macrostructure) within monologues. At an individual level, different patterns were seen between monologues and dialogues that shed greater light on the interaction between these genres.

# Discussion

Despite robust improvement in monologic discourse reported by Whitworth, Leitão, et al. (2015), parallel gains were not seen at the group level in conversation, suggesting that conversation is either not the most appropriate context for demonstrating change in functional discourse or that our methods require refinement. With the exception of a significant reduction in single phrases, the gains seen at the word and sentence levels did not generalise to conversation. There was also no change seen in the informative measure used across the conversation samples. Individual analysis of data however provided greater insight into the interaction between the genres. This paper will explore the complex theoretical and methodological reasons for the findings of this study and implications for measuring change in conversation within the clinical setting.

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