# Comparing EMG and voice key responses as indicators for speech onset time in EEG research on speech production

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# Stem- Spraak- en Taalpathologie

## 18th International Science of Aphasia Conference
## Geneva, 11-14 September 2017

# Stem- Spraak- en Taalpathologie

Geneva, 11-14 September 2017

Supplement

18th International Science of Aphasia Conference


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# PREFACE

Dear participants,

We are very pleased to welcome you to the 18th Science of Aphasia (SoA) conference, being held from September 11 till September 24, 2017 at the University of Geneva in Switzerland. The University of Geneva (UNIGE), is a public institution founded in 1559 by Jean Calvin dedicated to thinking, teaching, dialogue and research. It offers more than 500 Bachelors, Master and doctoral programmes to 16'500 students. Just like the city of Geneva itself, the university enjoys a strong international reputation, both for the quality of its research and the excellence of its education.

The program theme of the 18th Science of Aphasia conference is: **Neurotechnology and language**

Invited speakers are: Adrian GUGGISBERG (Geneva University and Hospital); Argye HILLIS (Johns Hopkins University, Baltimore, US), Alex LEFF (UCL, London, UK), Marcus MEINZER (Univ. Queensland, Australia), John ROTHWELL (UCL, London, UK), Riitta SALMELIN (Aalto University, FI), Karsten STEINHAUER (McGill, Canada), Mieke VAN DE SANDT-KOENDERMAN (Rijndam Rehabilitation & Erasmus MC, Rotterdam, NL).

The SoA conference brings together every year since 2000 senior and junior scientists working in the multidisciplinary field of *aphasia* and of *brain and language* and dealing with normal and impaired language functions. The size of the conference is limited to about 120 participants to ensure direct interactions between the participants. The focus of this year's conference is on *Neurotechnology and Language*. The program comprises four thematic sessions on neurotechnology and language, each given by two invited speakers and followed by discussions. There are also three oral communication sessions and four poster sessions as well as four workshops. In order to enable maximum discussion and interaction among participants, ample time is scheduled for poster sessions and for the on-site coffee and lunch times.

We lool forward to a stimulating and pleasant conference!
The organizing committee of SoA2017

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# Organization

The 18th International Science of Aphasia Conference is held at the University of Geneva, Switzerland, September 11-14, 2017.

**Chair***:*
Local Chair: Marina Laganaro, University of Geneva, Switzerland

**The scientific committee is composed of:**

**Local Committee:**
*Psycholinguistics and Speech and Language Pathology Group, FPSE, University of* Geneva
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**Abstract Booklet**
Alice Pomstra

# Conference Program

*18th Science of Aphasia Conference University of Geneva, Switzerland 11-14 September 2017*

## Monday, September 11, 2017 (UniMail, MS150)

**8.15 – 9.00 Registration**

**9.00 – 9.15 Welcome and Introduction**

**9.15 – 12.15 Invited talks 1 & 2 fMRI, DTI, VLSM**

*Alex LEFF* (UCL, London, UK): *Can structural imaging help predict patients' responses to behavioural therapies?*

10.15-10.45: coffee

*Argye Hillis,* Johns Hopkins University, USA – *No matter how you slice it…*

11.45-12.30: *Discussion (Moderator & discussant D. Howard)*

**12:30 - 14:00 Lunch (Cafeteria UniMail)**

**14:00 – 15:40 Contributed papers oral session 1**

FIEDER, Nora; WARTENBURGER, Isabell; ABDEL RAHMAN, Rasha. *Nearest but not dearest: Effects of semantic neighbourhood distance and density on word production*.

GAUVIN, Hanna Summer; MCMAHON, Katie; MEINZER, Marcus; DE ZUBICARAY, Greig. *Brain Mechanisms of Semantic Interference in the Picture-Word Interference Paradigm: An anodal transcranial direct current stimulation (aTDCS) study*

KENDRICK, Luke; ROBSON, Holly; ELLIS, Judi; METEYARD, Lotte. *Measuring executive control abilities in aphasia*

MURTEIRA, Ana Filipa; NICKELS, Lyndsey. *Effects of gesture observation on action-picture naming in people with aphasia*

PYTHON, Gregoire; GLIZE, Bertrand; MOLLO, Clémence; LAGANARO, Marina. *Sensitivity to semantic facilitation vs interference in picture naming in mild chronic aphasia*

**15.45 –16.15: Coffee**

**16.15 – 17.45 Poster Session I**

**16:15-16:45 Short (3 slide) presentations poster session 1, then poster session (3rd floor)**

BRUCE, Carolyn; GEORGE, Leya; JAMES, Philippa; ATHANASIADOU, Christina; NEWTON, Caroline. *Investigating the effectiveness of "SWAN", a digital game for remediation of acalculia in adults with aphasia*

CIACCIO, Laura Anna; BURCHERT, Frank. *Morphological errors in reading prefixed words: Investigations on a patient with deep dyslexia*

CORDONIER, Natacha; FOSSARD, Marion; CHAMPAGNE-LAVAU, Maud. *Irony comprehension in right-frontal brain-damaged patients: the role of context*

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FLEMING, Victoria; COLEY-FISHER, Henry; CRINION, Jenny; KRASON, Anna; LEFF, Alex; BROWNSETT, Sonia. Listen-In: *High-dose home-based auditory comprehension therapy is achievable and effective – preliminary findings*
KADYAMUSUMA, McLoddy Rutendo. *Frequency of use and its influence on the reading of indigenous languages: Reading time reference violations in Shona*
KRASON, Anna; BROWNSETT, Sonia; FLEMING, Victoria. Listen-In: *Qualitative findings of involving people with aphasia in the development of a home--based auditory comprehension therapy application*
MALYUTINA, Svetlana; OOSTERHUIS, Elise J.; ZELENKOVA, Valeriya; BUIVOLOVA, Olga; ZMANOVSKY, Nikita; FEURRA, Matteo. *Targeting interhemispheric balance to modulate language processing: A tDCS study in healthy volunteers*.
METEYARD, Lotte; ROBSON, Holly; ELLIS, Judi; KENDRICK, Luke. *Exploring impaired vs. spared learning performance in aphasia*
PESTALOZZI, Maria I.; DI PIETRO, Marie; MARTINS GAYTANIDIS, Chrisovalandou; CHOUITER, Leila; COLOMBO,Françoise; SPIERER, Lucas; SCHNIDER, Armin; ANNONI, Jean-Marie; JOST, Lea B.. *Effects of prefrontal transcranial direct current stimulation on language production in post-stroke aphasia*
PILKINGTON, Emma Clare; SAGE, Karen; SADLY, Douglas; ROBSON, Holly. *Lexical Activation in Jargon Reading and Repetition*
SCHUMACHER, Rebecca; BURCHERT, Frank; ABLINGER, Irene. *Specifying the underlying deficits in German patients with acquired dyslexia*

## **Tuesday, September 12, 2017** (UniMail, MS150)

**9.00 – 12.00 Invited talks 3 & 4 : tDCS**

*Mieke Van de Sandt* (Rijndam Rehab & Erasmus MC, Rotterdam, NL). *tDCS: a useful clinical tool, or a failed promise?*

10:00-10:30: coffee

*Marcus Meinzer* (U. Queensland, Australia) *Can we enhance language recovery after stroke by transcranial direct current stimulation?*

11:30-12:15: *Discussion (Moderator & discussant G. MICELI)*

**12:15 – 13.30 Lunch (Cafeteria UniMail)**

**13.30 – 15.30 Contributed papers oral session 2:**
ARSLAN, Seckin; GÜR, Eren; FELSER, Claudia. *Individual variability and linguistic constraints on the comprehension of wh-questions in Turkish and German aphasia*
GARRAFFA, Maria; SEDDA, Anna. *Core regions for syntactic processing? A tDCS study on the language network.*
MAN, Grace; FREDERICK, Jennifer; LEE, Jiyeon. *Effects of attentional and lexical cues on syntactic production in aphasia: eyetracking-while-speaking*
MARTÍNEZ-FERREIRO, Silvia; ISHKHANYAN, Byurakn; BOYE, Kasper. *Prepositions in Transcortical and Mixed aphasias*
NEWTON, Caroline; THORNLEY, Helena; BRUCE, Carolyn. The influence of emotional valence on word recognition in people with aphasia
OSSEWAARDE, Roelant Adriaan; JONKERS, Roel; JALVINGH, Fedor; BASTIAANSE, Roelien. *Measurement of speech parameters in casual speech of dementia patients*

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**15.30 –16.00: Coffee**

**16.00 – 17.30 Poster Session 2**

**16:00-16:30 Short (3 slide) presentations poster session 2, then poster session (3rd floor)**

ANDRADE FEIDEN, Juliana; POPOV, Srđan; BASTIAANSE, Roelien. *The Role of Conceptual Number: An ERP Study on Pronoun Processing in Brazilian Portuguese.*

DEN HOLLANDER, Jakolien; BASTIAANSE, Roelien; JONKERS, Roel. *Comparing EMG and voice key responses as indicators for speech onset time in EEG research on speech production*

FOSSARD, Marion; WILSON, Maximiliano; LEFEBVRE, Laurent; MONETTA, Laura; RENARD, Antoine; TRAN, Thi Mai; MACOIR, Joël. *DTLA - A New Detection Test for Language Impairment in Adults and the Aged*

FRANKE, Marina; NEVINS, Andrew; BRUCE, Carolyn; ZIMMERER, Vitor Cesar. *Dealing with constraints: Analysis of a visual language devised by a man with fluent aphasia*

HEILEMANN, Claudia; ZIMMERER, Vitor C.; VARLEY, Rosemary; BEEKE, Suzanne. *"A great deal" versus "a fair deal": Does collocation strength determine processing speed in aphasia?*

HÜBNER Lilian Cristine; LOUREIRO Fernanda; SMIDARLE Anderson Dick; RODRIGUES PEDRO Jennifer; MONTICELLI Vitor; TREVISO Marcos V.; BORGES DOS SANTOS Leandro; PORCELLO SCHILLING Lucas; , LESSA MANSUR Letícia; ALUÍSIO Sandra Maria. *Automatically distinguishing Mild Cognitive Impairment, Alzheimer's Disease and education effect in healthy aging in narratives in Brazilian Portuguese.*

IVASKÓ, Lívia; TÓTH, Alinka; PETRICH, Ákos; PUSZTA, András; NAGY, Attila; BENEDEK, György. *Mismatch negativity and category specificity in Hungarian - an EEG study*

ROSELL-CLARI, Vicent; HERNÁNDEZ-SACRISTÁN, Carlos. *Language awareness and aphasia assessment: differentiating profiles through the performance of metalinguistic tasks*

VUKOVIC, Mile G.; VUKOVIC, Irena. *The assessment of verbal fluency in patients with fluent and nonfluent aphasia.*

ZANINI, Chiara; FRANZON, Francesca; SEMENZA, Carlo; PERESSOTTI, Francesca; BROTTO, Silvia; GASTALDON,
Simone; ARCARA, Giorgio. *The encoding of numerosity in quantification expressions. Insight from an ERP study.*

## Wednesday, September 13, 2017 (UniMail, MS150)

**9.00 – 12.00 Invited Talks 5 & 6: ERP's, MEG & EEG**

*Riitta SALMELIN* (Aalto University, FI) *MEG measures as probes of cortical language function*

10.15-10.45: coffee

*Karsten STEINHAUER* (McGill, Canada) *Some DOs and DON'Ts in psycholinguistic and clinical ERP studies*

**12:15 - 14:00 Poster session 3 & Lunch (standing) 3rd floor**

**12.15 – 12.45 Short (3 slide) presentations poster session 3**

AVERINA, Svetlana; DRAGOY, Olga; AKININA, Yulia; BASTIAANSE, Roelien. *Dynamic aphasia accompanied by subcortical and insular damage: A single-case study*

BONNANS, Caroline; FARGIER, Raphaël; LAGANARO, Marina. *Dual-tasks interference in word planning processes in aphasia depends on the underlying impairment*.

DE BEER, Carola; HOGREFE, Katharina; DE RUITER, Jan. *Speech and gesture production by people with aphasia under varying communicative demands.*

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D'HONINCTHUN, Peggy; CHARPIE, Christelle; CLARKE, Stéphanie. *Restoration of both conceptual knowledge and word form retrieval in a case of semantic dementia in two compared treatments*
FARGIER, Raphaël; PELLET-CHENEVAL, Pauline; ASSAL, Frédéric; LAGANARO, Marina. *Typicality advantage for exemplars in picture naming and word-picture matching: Evidence from a case study of semantic variant of PPA*
FASOLA, Alexia; TELLIER, Marion; ALARIO, François-Xavier; TASSINARI, Carlo Alberto; TREBUCHON, Agnès. *Bimodal language in post-ictal aphasia*
FOURNET, Maryll; PERNON, Michaela; LOPEZ, Ursula; CATALANO CHIUVÉ, Sabina; LAGANARO, Marina.*Bidirectional interference effects in a verbal and non-verbal dual-task paradigm*
GRINDROD, Christopher Mark. *Verbal Fluency in Aphasia: Temporal Changes in Clustering and Switching*
KHUDYAKOVA, Mariya V. *Lexical Diversity in Different Types of Aphasia*
KUEMMERER, Dorothee; RIJNTJES, Michel; CONTERNO, Martina; MADER, Irina; NITSCHKE, Kai; WEILLER, *Cornelius. Phonemic and semantic paraphasias in acute aphasic patients – a voxelwise lesion-behavior mapping study*
PELLET CHENEVAL, Pauline; VILLAIN, Marie; GLIZE, Bertrand; LAGANARO, Marina. *Phonological cueing in picture naming: first phoneme cohort size effects in healthy and aphasic speakers.*

**14.00 – 15.40 Contributed papers oral session 3**
CODE, Chris; HILL, Asti; BLEVINS, Rachael*. Revisiting The Public Awareness of Aphasia in Exeter: 15 Years On*
CROOT, Karen; RAISER, Theresa; TAYLOR-RUBIN, Cathleen; RUGGERO, Leanne; ACKL, Nibal; WLASICH, Elisabeth; STRENGLEIN-KRAPF, Gisela; ROMINGER, Axel; DANEK, Adrian; NICKELS, Lyndsey*. Long-term treatment of lexical retrieval in Primary Progressive Aphasia*
DIGNAM, Jade; COPLAND, David Andrew; KOH, Jing Ting; CRAWFORD, Monica; FARRELL, Anna; BURFEIN, Penni; O'BRIEN, Kate; RODRIGUEZ, Amy. *The influence of treatment intensity on anomia therapy outcomes in chronic post-stroke aphasia*
DRAGOY, Olga; KUPTSOVA, Svetlana; CANESSA, Nicola; ZINCHENKO, Victoria; STUPINA, Ekaterina; PETRUSHEVSKY, Aleksey; FEDINA, Oksana; CAPPA, Stefano*. The contribution of corpus callosum to lateralization of the resting state language network*
GLIZE, Bertrand; VILLAIN, Marie; LAGANARO, Marina; JOSEPH, Pierre-Alain; GUEHL, Dominique; SIBON, Igor. *Motor Evoked Potentials of upper-limbs predict aphasia recovery*

**15:45 – 16:30 : Jürg Schwyter presents : [jürg] (30 min film, English version)**
*SYNOPSIS : February 2009, Jürg Schwyter, Professor of Linguistics at the University of Lausanne, suffered a massive stroke and became aphasic. The film [jürg] gives a personal perspective of his fight to reclaim his speech, a place in life and, finally, the return to part-time lecturing at Lausanne University. [jürg] was made by Raphaël Meyer and is being shown at over half a dozen short film festivals; it won the Jury Prize and Audience Prize at the Schweizer Jungendfilmtage in Zürich.*

**18.00 – 22.00 : Social event (Boat trip and Dinner)**

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## Thursday, September 14, 2017 (UniMail, MS150)

**9.00 – 1200 Invited talks 7 & 8 : TMS**

John ROTHWELL (UCL, London, UK) *Is TMS more useful to study mechanisms of aphasia than as a therapy?*

10:00-10:30: coffee

Adrian GUGGISBERG (Geneva University and Hospitals) *The problem of individually variable responses to rTMS: a network perspective"*

11.30-12.15: Discussion (Moderator & discussant R. BASTIAANSE)

**12.15 – 14.:00 Poster Session 4 & Lunch (standing) – 3d floor**

**12:15 – 12:45 Short (3 slide) presentations poster session 4**

AKININA, Yulia; BASTIAANSE, Roelien. *Verb and Sentence Test in Russian: a showcase of two people with fluent aphasia*

ALMUZAINI, Shams Obaid; ALABDULKARIM, Lamya; TETTERSALL, Catherine; HERBERT, Ruth. *Number and Gender Agreement in Saudi Arabic Agrammatism*

ALTAIB, Madhawi Khalid; METEYARD, Lotte; MARINIS, Theo. *The Gulf-Arabic Aphasia Screen*

FRANZON, Francesca; ZANINI, Chiara; QUADRI, Ilaria; SEMENZA, Carlo. *Mass reference and its encoding into language. A preliminary study in aphasia.*

KONSTANTINOPOULOU, Polyxeni; STAVRAKAKI, Stavroula; MANOUILIDOU, Christina; ZAFEIRIOU, Dimitrios.

Expressive syntactic abilities and verbal short term memory in children with focal brain lesion

LARTEY, Nathaniel; TSIWAH, Frank; BASTIAANSE, Roelien. *Characterization of agrammatism in Akan*

LEE, Jiyeon; MAN, Grace; FERREIRA, Victor; GRUBERG, Nicholas. *Aligning sentence structures in a language game: evidence from healthy aging and aphasia*

MEITANIS, Vanessa; TUOMAINEN, Jyrki; VARLEY, Rosemary. *Online sentence processing in adults and individuals with aphasia*

STRINZEL, Michaela; VERKHODANOVA, Vass; JALVINGH, Fedor; COLER, Matt; JONKERS, Roel. *A pilot study on the effects of Parkinson's Disease with and without Mild Cognitive Impairments on vowel articulation in spontaneous speech*

TOPS, Wim; NEIJMEIJER, Silke; MARIËN, Peter*. Effects of regiolects on the perception of developmental foreign accent syndrome*

ZIMMERER, Vitor Cesar; COLEMAN, Michael; HINZEN, Wolfram; VARLEY, Rosemary. *Reliance on common word combinations correlates with degree of syntactic impairment in aphasia*

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**14:00-17:15 Parallel Workshops**

| | |
|---|---|
| A. TMS-tDCS (Room: UniMail R160) | B: EEG/ERP. (Room: UniMail 4183) |
| **14:00-15:30** | |
| A1. tDCS. (Room: UniMail R160)<br>Mieke van de Sandt (Rotterdam, NL) | B1. Recording and pre-analyses (beginners)<br>R. Fargier & M. Cohen (U. Geneva) |
| **15:45-17:15** | |
| A2. TMS. (Room: UniMail M2150)<br>S. Carstens (ANT Neuro Company) | B2. From waveform to microstate analysis (advanced) R. Fargier & M. Cohen (U. Geneva) |

Visit our website for further information: http://www.unige.ch/fapse/SoA2017/

Location
The SoA 2017 conference will take place in the UniMail building, at the University of Geneva

# Nearest but not dearest: Effects of semantic neighbourhood distance and density on word production.

Nora Fieder[1], Isabell Wartenburger[2] & Rasha Abdel Rahman[3]

*1 Humboldt-Universität zu Berlin, Berlin School of Mind and Brain, Germany*
*2 Department of Linguistics, Center of Excellence Cognitive Science, University of Potsdam, Germany*
*3 Department of Psychology, Humboldt-Universität zu Berlin, Germany*

## Introduction

This study investigated how lexical selection is influenced by the number and the similarity of semantically related representations (semantic neighbours - SN). Specifying the underlying mechanism of lexical selection is important because it is one of the first and most critical steps that determines whether a target word's meaning and lexical representation is successfully selected from many simultaneously activated, semantically related lexical representations for language production. It still remains unclear how the lexical system can recognise and thus select the target amongst the cohort of co-activated SN. There are two major theories of lexical selection: non-competitive theories (Dell, 1986) and competitive theories (e.g., Levelt, Roelofs & Meyer, 1999; Wheeldon & Monsell, 1994). Competitive theories assume that lexical processing and selection of a target word is influenced by its SN: In order to be selected the target's lexical representation has to compete with and thus overcome interference from its SN. Non-competitive theories propose that SN do not compete and thus directly influence the selection of the target's lexical representation.

Semantic neighbourhood is one variable that can be used to assess directly the underlying mechanism of lexical selection. However, previous studies that assessed the influence of SN- density or distance in language production with aphasic and language unimpaired speakers found mixed effects ranging from no effects (e.g., for language unimpaired speakers: Bormann, 2011; Hameau, Biedermann & Nickels, submitted), to inhibitory (e.g., Mirman, 2011) or even faciliatory effects (Hameau et al., submitted; Kittredge, Dell & Schwartz, 2007) of SN which leaves the question of the underlying mechanism of lexical selection unresolved.

The present study aimed to follow-up on this issue by providing empirical evidence on the exact role of the different aspects of SN for language production. We used a tempo picture naming task as it was found to be suitable to study language production errors that are similar to the errors of language impaired speakers (e.g., Kello, 2004; Mirman, 2011). This paradigm allowed us to assess effects of SN-variables not only on naming latency and accuracy, but also on the production of different error types.

Our predictions are the following. If lexical selection is competitive, we predict to find an interference effect of SN with competition and thus interference to increase with the number and/or similarity (distance) of a target's SN. We hypothesize that words with many SN and/or many near SN are more likely to result in less accurate naming responses and an increase in the production of semantic errors and no responses compared to words with few SN and/or few near SN. In contrast, if lexical selection is non-competitive, we predict to find no effects of SN.

# Methods

## *Participants*

Thirty German speaking participants (24 females) with no history of language impairment.

## *Design & Procedure*

A tempo picture naming task was used for this investigation in which participants were set to and then requested to keep a fast tempo of 500 ms when naming pictures. At the beginning of each trial, participants heard a series of three beeps in combination with numbers which counted down from 3, 2, 1. After the rapid countdown, participants were presented with the target picture for 500ms and were asked to name the picture as quickly as possible before the fifth beep and the number zero appeared. Vocal responses were recorded until the timeout of 2000ms.

# Results

The results showed effects of SN-distance, but not of SN-density. Words with many near SN were named slower ($t$ = -1.691, p = .093) and less accurate (z = -2.846, p = .004) compared to words with few near SN (see Figure 1). Moreover, we found significant effects of SN-distance on the production of error types that can be related to difficulties in lexical selection: The production of semantic errors ($z$ = 2.247, $p$ = .025) and no responses ($z$ = 2.850, $p$ = .004) compared to correct responses increased with the number of near SN.

# Discussion

This is the first study to investigate the influence of SN-density and SN-distance in word production with language unimpaired speakers. Unlike previous studies, we found converging evidence for an influence of SN-distance not only on naming latency and accuracy, but also on the production of different lexical-semantic error types. Words with many near SN led to an increase in naming difficulty and thus resulted in longer naming latencies, less accurate naming responses and as a consequence in an increased production of semantic errors and no responses. No effect was found for SN-density.

The results of this study confirm the predictions of a competitive mechanism of lexical selection. The influence of semantically near neighbours can be implemented in form of lateral inhibitory links between semantically related representations at the lexical level (see Cooper Cutting & Ferreira, 1999; Howard, Nickels, Coltheart & Cole-Virtue, 2006). In this scenario, a target's lexical representation would be inhibited and thus it's activation level would be lowered in correlation to the number of near and thus semantically very similar representations (near SN).

What are the study's implications for word finding difficulties in aphasia? Given the similarity between word finding difficulties and errors produced by language unimpaired speakers in the tempo picture naming task compared to aphasic speakers with lexical and/or semantic impairment, SN-distance is likely to be a critical factor that can determine the ease and thus success of lexical selection in aphasia. We would therefore suggest not only to control for SN-distance in experimental studies but also to consider it for future assessments and treatment.

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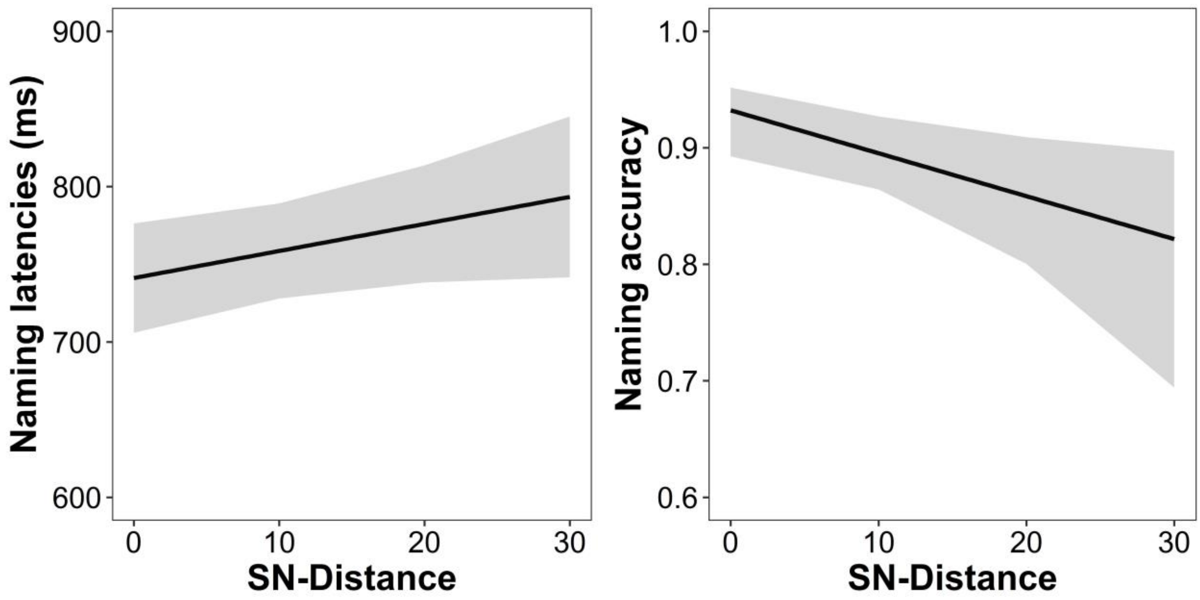
*Figure 1*. Effects of semantic neighbourhood distance on naming latency and accuracy (accurate versus inaccurate responses).



# Brain Mechanisms of Semantic Interference in the Picture-Word Interference Paradigm: An anodal transcranial direct current stimulation (aTDCS) study

*Hanna Gauvin[1], Katie McMahon[2], Marcus Meinzer[2], Greig de Zubicaray[1]*

*[1]Queensland University of Technology, Brisbane, Australia. [2]University of Queensland, Brisbane, Australia*

## Introduction

Naming a picture is slower in categorically related compared to unrelated contexts, an effect termed semantic interference. In the picture-word interference (PWI) paradigm, participants are instructed to name pictures while ignoring accompanying distractor words. Demonstrations of semantic interference in the PWI paradigm have informed the development of all contemporary models of lexical access in speech production. Neuroimaging studies of semantic interference in PWI have emphasized important roles for left posterior middle and superior temporal gyri (pMTG/STG) and inferior frontal gyrus (IFG) in lexical-semantic processing and resolving competition during selection among between competing representations, respectively.

## Methods

In a three-way, cross-over, sham-controlled study, we applied online anodal transcranial Direct Current Stimulation (atDCS) to LIFG or pMTG/STG while 30 participants performed the PWI paradigm with superimposed categorically related, unrelated, and congruent (identity) written distractor words.

## Results

Linear Mixed Effects (LME) analysis showed significant effects of distractor condition and an interaction with aTDCS. Specifically, aTDCS to LIFG significantly increased the magnitude of the semantic interference effect compared to sham. In addition, aTDCS to both LIFG and pMTG/STG significantly increased naming RTS compared to sham for congruent distractors.

## Discussion

We interpret these results as indicating semantic interference in PWI reflects contributions of both lexical-level activation and inhibitory control mechanisms.

# Measuring executive control abilities in aphasia

*Luke T. Kendrick[1], Holly Robson[1], Judi Ellis[1], and Lotte Meteyard[1]*

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## Introduction

There is renewed interest in how the broader cognitive profile of persons with aphasia (PWA) can impact language recovery (See Cahana-Amitay & Albert, 2014). For example, reduced executive control abilities are a prevalent feature of post-stroke aphasia (Helm-Estabrooks, 2002; Keil & Kaszniak, 2002) and are associated with limited gains from therapy, poor generalisation beyond therapy, and poorer functional communication (Fillingham et al., 2005; Fridriksson et al., 2006; Yeung & Law, 2009). Yet measuring executive control in individuals with aphasia is challenging. Many tasks place substantial demands on language processing (i.e., linguistic stimuli, complex task instructions, and oral responses). Consequently, poor performance on executive control tasks may be a result of language difficulties in PWA.

In order to bypass language difficulties, some studies have administered executive control tasks with *reduced* verbal load and comparing these with verbal tasks (verbal vs. non-verbal comparison). These studies have shown that PWA show reduced executive control abilities, consistent across both verbal and *reduced* task versions. Therefore, impoverished executive control abilities are not restricted to the language domain (Murray, 2016; Kuzmina & Weekes, 2016). However, these findings should be considered preliminary given the limited set of executive control measures/screens used.

The overall aim of this study was to extend these previous studies using a larger battery of executive control measures. Firstly, we examined the profile of executive control abilities in PWA (Question 1: are executive control abilities reduced in aphasia?). Secondly, we compared verbal and *reduced* verbal task versions (Question 2: are there differences between verbal and *reduced* verbal tasks?). As per previous studies, equivalent performance on both verbal and *reduced* verbal task versions would indicate executive control deficits are not restricted to the language domain, and are potentially domain-general in nature (Kuzmina & Weekes, 2016).

## Methods

### *Participants*

Ten adults with post-stroke aphasia ($M^{AGE}$ = 63.8, $SD^{AGE}$ = 8.12) and fifteen age and education matched controls ($M^{AGE}$ = 64.2, $SD^{AGE}$ = 8.14) took part in the study. Participants with aphasia were at least two years post-onset, presented with non-fluent spoken output, and had lesions affecting the left insula (n=9) and left inferior frontal gyrus (n=8).

### *Procedure*

All participants completed a battery of executive control tasks, which were adapted for use with aphasia (i.e., aphasia friendly instructions, no oral responses). Tasks were selected to tap into multiple specific executive control abilities. These included measures of inhibition (Stroop tasks, Flanker tasks), switching (blocked vs. switch tasks), and updating (N-back tasks). For each task we included verbal and *reduced* verbal versions (e.g., traditional word vs. spatial Stroop tasks). Participants also completed the Wisconsin Card Sort Task (WCST).

# Results

## *Question 1: Do PWA show reduced executive control?*

We performed group analyses using mixed effects models comparing PWA with controls on executive control tasks, examining both reaction time (RT) and accuracy performance (i.e., RT ~ Group*Condition*Task Type). Our findings show that, compared to controls, PWA demonstrated significantly slowed response times on all reaction time tasks. For accuracy, PWA performed below controls on the switching and n-back tasks, but not inhibition tasks or the WCST.
In summary, PWA show general slowing but are accurate on inhibition tasks. For switch tasks PWA are both slowed and less accurate. Finally, on both N-back tasks PWA perform below that of controls.

## *Question 2: Are there differences between verbal and reduced verbal tasks?*

Our findings show that despite the clear group effects (described above); there were no significant group by task type interactions (all $p > .05$). In other words, PWA show equivalent performance on both verbal and non-verbal tasks. We also examined individual performance to explore potential dissociations within the aphasia group (i.e., individuals showing impaired verbal but spared *reduced* verbal performance). Crawford's Revised Standardized Difference t-tests revealed that dissociations between task versions were infrequent, with only 6/40 comparisons yielding a significant dissociation.

# Discussion

The first aim of this study was to profile executive control performance using a theoretically driven battery of tasks that are suitable for use in aphasia. Our findings show that PWA do demonstrate reduced executive control abilities, but varies between tasks (i.e., slowed RT on inhibition tasks, slowed RT and poor accuracy on Switch tasks). The WCST on the other hand was unable to detect group differences. Our findings highlight the importance of using multiple and carefully selected tasks when examining executive control in aphasia (e.g., Keil & Kaszniak, 2002; Miyake, Emerson, & Friedman, 2000).
When comparing verbal and *reduced* verbal task versions, our findings show that in both controls and PWA, performance between task versions was equivalent. These findings extend previous studies showing that dissociations between verbal and non-verbal executive control tasks are infrequent. This suggests that observed executive control deficits are not necessarily restricted to the domain of language, and are potentially domain-general in nature (see Murray, 2016; Kuzmina & Weekes, 2016). Future analyses will examine how performance on our executive control battery relates to language abilities.

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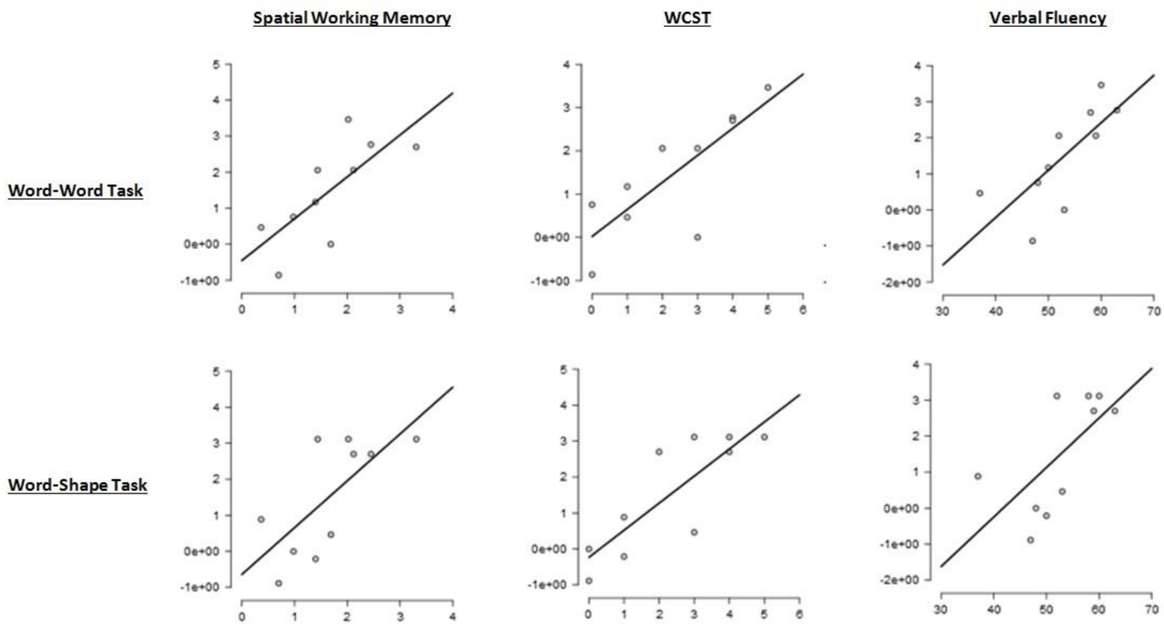

# Effects of gesture observation on action-picture naming in people with aphasia

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## Introduction

Gesture is critical component of human communication and theoretical models of gesture-speech integration suggest an interplay between conceptual, linguistic and gestural domains (de Ruiter, 2000; McNeill, 2000). In aphasia research, it has been suggested that gesture can play a role in the treatment of naming impairments (Rose, 2006). However, investigation is still sparse, especially compared to research on verbal treatments for word retrieval (Nickels, 2002). Moreover, questions about the extent to which gesture may influence lexical retrieval and, in particular, action naming remain almost unanswered.

Intervention studies with people with aphasia (PWA) have found positive changes on picture naming when combining gesture and verbal treatment techniques (Raymer et al, 2006; Rose & Sussmilch, 2008). When gesture-only treatment was used, some studies found little difference between gestural and verbal techniques (Rose & Douglas, 2008) or no advantage for the use of gesture as a cue to naming (Marshall et al, 2012). There is, however, some evidence that a beneficial effect of gesture depends on the type and severity of the linguistic impairment (Kroenke et al, 2013). Nevertheless, in all previous studies, gesture has been a target of training (i.e. PWA were requested to produce a gesture). This leaves open the question of whether gesture observation alone (without production) can influence word retrieval in PWA. This is particularly interesting in light of the fact that we recently found that, in healthy speakers, verb production could be facilitated by mere exposure to semantically congruent gestures (Murteira, Sowman & Nickels, 2016).  The present study therefore, uses the same paradigm to investigate the effect of gesture observation on action-picture naming in PWA. Understanding the mechanisms underlying the interface between gesture and language can help us to make the best use of gesture to facilitate speech production in PWA.

## Methods

### *Participants*

Six participants (2 female) with chronic post-stroke aphasia were recruited using a (loose) criterion of some degree of impairment (but some ability) in naming pictures. All participants presented with a single unilateral left-hemisphere CVA, no previous history of other neurological conditions, no other marked cognitive co-morbidities and ranged from mild to severe aphasia. Participants were assessed on a range of gesture and language processing tasks from a selection of standardised tests (e.g., sub-tests from the Florida Apraxia Battery – Extended and Revised Sydney (Power, Code, Croot, Sheard & Gonzalez-Rothi, 2010); sub-tests from the Comprehensive Aphasia Test (Swinburn, Porter & Howard, 2004).

### *Experimental task*

The experimental task involved the presentation of gesture primes followed by action-pictures for naming of target verbs. For each target verb, a pantomimed gesture was created, consisting of a 900ms video clip of a person miming the corresponding action.

Participants were asked to name 72 action-pictures, using a single verb, presented in three conditions: paired with a match gesture (match condition), paired with a mismatch gesture (mismatch condition) and paired with a black screen (neutral condition). Each participant completed three sessions, one week apart. In each session, a third of targets appeared in each condition. Each target verb appeared only once and in each session was presented in a different prime-target condition, such that over the three sessions every verb appeared in every condition.

# Results

Statistical analysis was performed at the group level and for each single-case, for measures of accuracy (all participants included) and reaction time of correct responses (PT4 and PT5 were excluded due to low accuracy across conditions).
Accuracy was analysed at the group level using a generalized mixed-effects model for binomial data. Results showed a significant increase in accuracy for the match condition as compared to the mismatched condition ($\beta$=-.58, SE=.17, p=.001) but not compared to neutral condition (Figure 1A). At individual level, preliminary analysis showed variability in the effect of gesture across the participants, with significant differences between conditions for PT3 (Cochrane's Q: $\chi2(2)$=14.41, p=.001), PT4 ($\chi2(2)$=8.97, p=0.01) and PT5 ($\chi2(2)$=7.52, p=.026). Only PT4 showed the pattern of the group analysis: observation of mismatch gestures had a negative effect, but there was no advantage of the match gesture compared to a non-gesture condition (planned comparisons: McNemar's test with Bonferroni correction). Gesture observation was facilitative only for PT3. For PT5 only the neutral condition facilitated accuracy. Despite the apparent individual variability, the inclusion of random slopes for participants within conditions did not improve the fit of the mixed-effects model, indicating that there was no evidence to support differences across participants.
Response latency was analysed, at the group level, using a linear mixed-effect model (a Box-Cox transformation was used to normalise the distribution). Results showed faster naming responses for the match condition as compared to mismatch ($\beta$=-.008, SE=.002, p<.001) and neutral conditions ($\beta$=-.006, SE=.002, p<.001) (Figure 1B). Two participants showed significant differences between conditions: PT6 (Friedman's ANOVA: $\chi2(2)$ = 12.4, p=.002) with significantly faster responses on the match condition as compared to neutral (Wilcoxon, z=-2.08, p=.02) and mismatch conditions (z=-2.85, p=0.002) and, PT1 ($\chi2(2)$ = 6.6, p=.04) with significantly faster verb naming on the match gesture condition, but the difference was only significant when compared to the mismatch condition (z=-3.23, p <.001). Again, despite individual differences, the inclusion of by-subject random slopes for condition did not improved the fit of the mixed-effects model, providing no support for different patterns across participants.

# Discussion

We have demonstrated that observation of semantically congruent gestures affects speed of response in people with aphasia, just as it does for non-impaired speakers. However, we found no significant benefit for accuracy of verb naming. In light of these results, caution is necessary regarding the clinical utility of gestural cueing.
The results are in line with literature supporting an interaction between gesture and the word production system (de Ruiter, 2000; Krauss et al, 2000). Based on the theoretical accounts in the literature (e.g., Collins & Loftus, 1975; Wheeldon & Monsell, 1992) we suggest that gesture could facilitate verb naming due to activation of overlapping semantic features between the gesture and the target verb or due to priming of the verb's lexical form.

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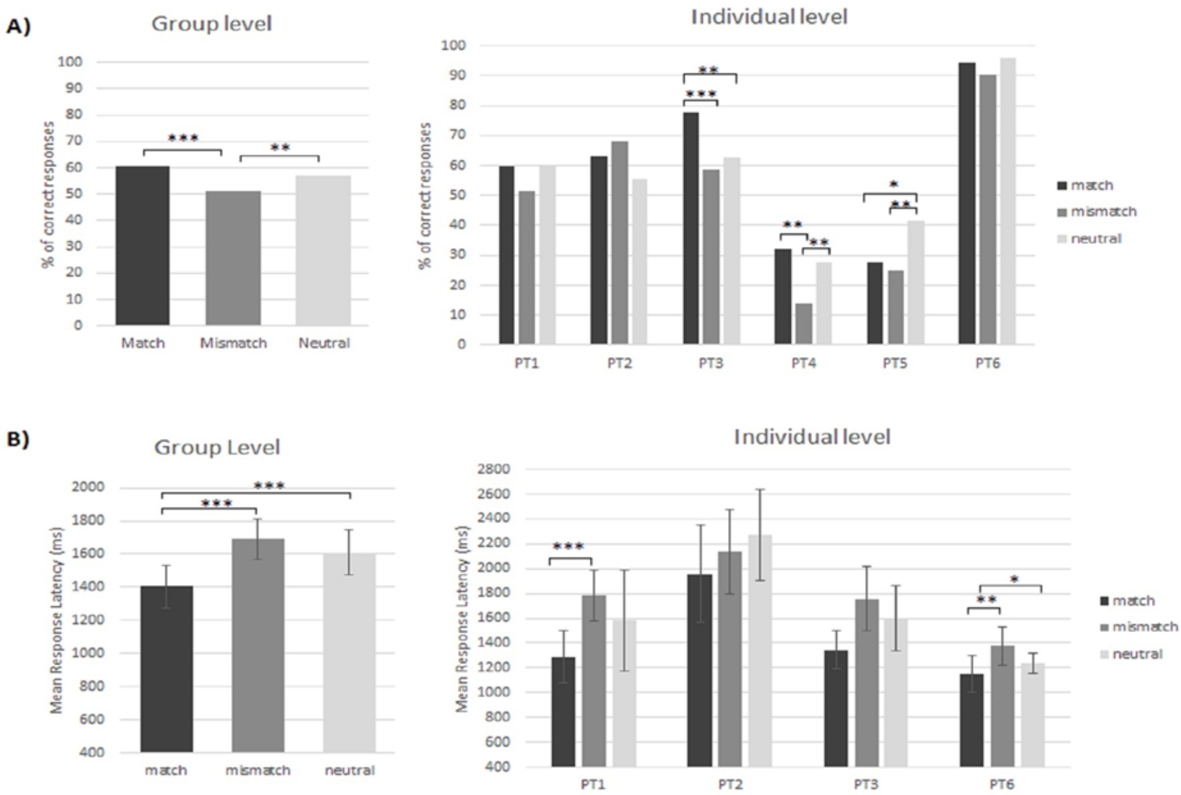


Figure 1. A) Accuracy for group and each individual participant, and summary of significant comparisons. B) Response latency (ms) for group and each individual participant, and summary of significant comparisons. Error bars=CI *p≤.05 **p≤.01 ***p≤.001

# Sensitivity to semantic facilitation vs interference in picture naming in mild chronic aphasia

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## Introduction

The picture-word naming paradigm (PWNP) has been extensively used to investigate lexical-semantic context effects on picture naming in healthy subjects (see Mahon, Costa, Peterson, Vargas, & Caramazza, 2007, for a review). Typical results on reaction times (RT) show semantic interference with categorical primes, but semantic facilitation with associative primes (Costa, Alario, & Caramazza, 2005). Another factor that can reverse the polarity of the semantic effect in the PWNP is the duration of the stimulus-onset asynchrony (SOA), short negative/null SOAs leading to interference and long negative SOAs to facilitation (Alario, 2001). In left brain-damaged patients, only two PWNP group studies have been published so far: Hashimoto & Thompson (2010) reported semantic interference in a group of 11 non-fluent aphasic patients (increased error rates and RT), whereas Piai, Riès, & Swick (2016) reported no reliable semantic interference on a group level (RT & errors) in 6 patients with a left lateral prefrontal lesion. In both studies, the semantic interference effect was rather heterogeneous across patients, with some of them showing semantic facilitation instead of the expected interference. The aim of the present study is to disentangle semantic facilitation and interference effects of categorical and associative primes in two PWNP in left brain-damaged and healthy participants. A better understanding of these processes is of interest for anomia assessment and therapy.

## Methods

### *Population*

15 French-speaking participants, who suffered from aphasia following a left hemispheric stroke 2 years earlier, participated in this study (aged 23-79, mean 60.5). They were presenting with mild anomia (> 90% correct responses at the Boston Diagnostic Aphasia Examination) and within normal range in a lexical-semantic comprehension task (>88% correct responses at the Pyramid and Palm Trees Test).
We also tested extended versions of this paradigm in two groups of 24 French-speaking young adults (aged 19-39, mean 24.9), with no significant history of neurological disorder.

### *Material & Procedure*

The participants had to name black and white line drawings from different semantic categories, preceded by word primes in 3 conditions: associative, categorical or unrelated (e.g. the target picture « airplane » was preceded either by « flight », « helicopter » or « string » respectively). Two versions of the PWNP were administered:

1) In the “facilitative” PWNP (fPWNP), 21 different pictures were used and word primes were presented auditorily (mean SOA = -700 ms).
2) In the “interfering” PWNP (iPWNP), 35 different pictures were used and the written word prime was presented very briefly before the picture onset (SOA = -66ms), as in Finkbeiner & Caramazza (2006).

# Results

**In healthy speakers**, the RT analysis in the fPWNP indicated shorter naming latencies with categorical primes as compared to unrelated primes (t=53.043, p<.001) and even shorter latencies with associative primes relative to categorical primes (t=7.031, p<.001). In the iPWNP, longer naming latencies were observed for categorical primes as compared to unrelated primes (t=3.499, p<.001), but no effect emerged with associative primes (t=-1.185, p=.24).
**In left brain-damaged patients**, the RT pattern was similar as in young healthy subjects, but a different pattern was observed on accuracy. In the iPWNP, categorical distractors (as compared to unrelated distractors) increased the error rate (Wilcoxon Signed Ranks Test, p=.046), whereas associative primes had no effect. The categorical interference effect was descriptively observed in 13/15 patients (hybrid score of RT and errors). In the fPWNP, the different primes did not modulate the error rate, although a categorical facilitation effect was descriptively observed in 10/15 patients. In addition, the overall error rate was higher in the iPWNP (mean 10.2%) than in the fPWNP (mean 6.6.%), and particularly for omissions/no responses (40% in the iPWNP vs 6% in the fPWNP ; z=-5.66, p<.001).

# Discussion

Using two PWNP in healthy speakers, we observed that picture naming can be speeded up or slowed down by categorical primes (as compared to unrelated primes), whereas associative primes induced a null effect or facilitation. Mild chronic aphasic speakers showed a similar pattern of RT. On a group level, their error rates revealed reliable semantic interference, but failed to show semantic facilitation. Moreover, the two opposite behavioral effects were not correlated (r=-.01), some patients being very sensitive to facilitation but not to interference and vice versa. Therefore, the common “semantic” origin of these effects is questioned. Finally, even 2 years post-stroke, some patients who showed good recovery on a classical test produced up to 43% errors in the PWNP, indicating that this task is sensitive to highlight the residual naming deficits in mild chronic aphasia.

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# Investigating the effectiveness of "SWAN", a digital game for remediation of acalculia in adults with aphasia

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## Introduction

People with aphasia often report that they are unable to understand and use mathematical information. Consequently, they have difficulties doing some of the simplest tasks such as saying their telephone number or calculating change – tasks most of us take for granted. Low levels of numeracy skills can impact on all aspects of an individual's life and can affect their confidence and self-esteem. Several studies have shown that adults with aphasia have difficulties performing operations with symbolic formats such as Arabic numerals, and that they have deficits in transcoding and counting (Lemer, Dehaene, Spelke & Cohen, 2003; Cappelletti, Butterworth and Kopelman, 2012). Some evidence suggests that automatic counting is better retained than non-automatic counting, where numbers are named in non-consecutive order (Lum and Ellis, 1999). When asked to name a number out of order, they can sometimes do this accurately, but they need to count up the sequence starting from one.

The current study is a case series, which aims to evaluate the effectiveness of a digital intervention designed to provide intensive training in counting and sequencing skills. The primary goals of the study were to determine whether performance improved significantly between the pre- and post-training periods and to identify which numerical skills were most sensitive to training.

## Methods

### *Participants*

Fifteen adults (12 men and 3 women), aged 44 – 85 years, with different types and severity of aphasia, were recruited. They all reported difficulties with counting and number processing.

### *Outcome Measures*

Participants were tested on a battery of linguistic and numerical tasks before and after three weeks of home training with "SWAN". A control task, nonword reading aloud, was also completed to exclude the possibility of spontaneous recovery. The numerical tasks tested included verbal counting, transcoding, calculations, functional numeracy and symbolic and nonsymbolic number comparison, although not all of participants completed all of the tasks. A postgame questionnaire evaluated participants' perceptions of the game.
We hypothesized that participants would show the largest improvement on tasks that depended on counting and sequencing and show little or no improvement in calculation, as this skill was not directly targeted by the intervention.

### *Intervention*

The intervention ("SWAN": Sequencing Words and Numbers) is a based on research in normal child development which suggests that learning the number-word sequence involves at least five different levels (Fuson, 1988). This includes the unbreakable list level where the sequence can only be produced by starting at the beginning, the breakable chain level where parts of the chain can be produced starting from arbitrary points and the final bidirectional chain level where words can be produced in either direction. It is possible that adults with aphasia have reverted back to a simpler level of counting and need to reacquire more advanced sequence skills if they are to produce numbers easily.

"SWAN" is a game-based intervention delivered via tablet computer that allows players to work through the different levels of number-word sequencing, as well as an increasingly wider range of numbers. It was designed to be fun and positive reinforcement was provided in order to maintain attention and motivation. The game involves tapping on tiles to create a sequence of numbers, the longer the better. The software was also designed to emphasize the association between Arabic numerals and number words ; the name of the number is said aloud each time a tile with an Arabic numeral is pressed.

Following a training session, participants were asked to play the game every day for a minimum of 15 minutes. They completed the intervention over the Christmas holiday, so that ongoing speech and language therapy would not confound the results.

# Results

None of the participants showed a significant improvement on the transcoding task. However, gains were made on the sequencing tasks. A significant improvement in accuracy was found across the group for the automatic sequencing task. Improvements were also observed in faster responses. Positive trends in accuracy were found for non-automatic sequencing tasks, with some individuals demonstrating significant improvements. Other participants, who scored at ceiling on these tasks, were quicker. Participants varied in their performance on the numeracy tasks with some improving their scores on the WRAT-3 (Wilkinson & Robertson 2006) as well as the functional numeracy task. All participants apart from one remained stable across time points on the control task. This suggests that gains made in sequencing, calculation and number related skills when using SWAN were not due to general recovery.

Qualitative data collected on the feedback questionnaires indicated that all participants enjoyed playing the app, although some issues arose with confusion of the level instructions, touch sensitivity and the bonus mechanics.

# Discussion

The results showed that after using the game, adults made improvements on several tasks, suggesting that the intervention was successful in improving basic numerical processing. Responses were quicker and there was less reliance on nonverbal strategies. Improved accuracy was not always observed because some participants scored at ceiling on tests. Unexpected changes in the numeracy tasks may have been due to better number naming, which reduced cognitive load.

These results are only a first step in determining the effectiveness of SWAN. The generality and duration of the effects found need to be tested.

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# Morphological errors in reading prefixed words: Investigations on a patient with deep dyslexia

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## Introduction

A number of psycholinguistic studies with healthy adults have suggested that morphologically complex words are decomposed during processing. This has been shown both for prefixed words, e.g. 'prepay', and suffixed words, e.g. 'payer' (Taft & Forster, 1975; Rastle et al., 2004). Several neuropsychological studies have provided further evidence for the decomposition hypothesis, based on the errors of patients with deep dyslexia, whose reading performance is characterized by the so-called 'morphological errors'; these involve the single constituents of complex words, generally affecting the affix while sparing the stem. Although some studies have objected against the morphological nature of such errors (e.g. Funnell 1987), further evidence for morphological errors in deep dyslexia was recently provided by Rastle et al. (2006). While the picture looks fairly clear when it comes to suffixed words, this is not the case for prefixed words, which have been under-investigated. The present study is the first specifically assessing the nature of morphological errors with prefixed words.

## Methods

NN is a German 64-year old man with a diagnosis for Broca's aphasia and deep dyslexia. In a reading aloud task, he was asked to read aloud a total of 123 experimental items and 116 fillers. The experimental items included the following subsets: (i) 45 prefixed verbs, matched to 20 prefixed nouns; this contrast was relevant because of the different stress pattern of prefixed verbs and nouns (the affix is stressed in nouns, but not in verbs); the prefixed nouns were additionally matched to (ii) 20 pseudo-prefixed nouns (e.g. *Insekt* 'insect', containing the prefix *in*- and the stem *Sekt* 'sparkling wine'); (iii) 20 nouns with an embedded stem (e.g. *Barock* 'baroque', containing *Rock* 'skirt'); (iv) 18 nouns with an embedded prefix (e.g. *Gepard* 'cheetah', containing *ge*-). The same materials were tested twice in two separate sessions.

## Results

NN correctly produced 57.5% (23/40) of the prefixed nouns and 31.8% (28/88) of the prefixed verbs; this difference was significant ($\chi$=7.567, $p$=.006). His performance with prefixed nouns was comparable to that with pseudo-prefixed nouns (45%, 18/40), nouns with embedded stems (55%, 22/40), and nouns with embedded prefix (55.6%, 20/36). Further analyses focused on the type of error produced. Errors were coded as 'constituent error' or 'other error'; constituent errors were defined as those errors where one constituent was spared and the other affected. Cases where the target was produced entirely but with the insertion of additional morphemes were counted as 'error' for the accuracy rates, but were not considered in further analyses. Prefixed verbs and nouns yielded a comparable amount of constituent errors (70%, 35/50; 64.3%, 9/14). The same was true for pseudo-prefixed words (70%, 14/20). On the contrary, words with an embedded stem or an embedded prefix yielded a lower number of constituent errors (6/16, 37.5%; 6/14, 42.9%). However, these differences were not significant. Unlike what has been described for suffixed words, constituent errors often involved stems. In the case of prefixed verbs and nouns, errors affected the stems in 54.3% (19/35) and 55.6% (5/9) of the cases. This figure was smaller for pseudo-prefixed words (35.7%, 5/14) and words with embedded prefixes (30%, 2/6), where most errors affected the (pseudo-)prefixes. As for words with embedded stems, the stems were always spared. Finally, we analyzed the type of errors involving the prefixes or initial syllables. Prefixes in prefixed nouns were always omitted and never substituted, while those in prefixed verbs were omitted in 37.5% (6/16) of the cases ($\chi$=5.000, $p$=.025). Prefixed nouns also behaved differently from pseudo-prefixed nouns and nouns with embedded stems, where the first syllable was omitted, respectively, in 22.2% (2/9) of the cases ($\chi$=6.741, $p$=.009) and in none of the cases ($\chi$=10.000, $p$=.002); in words with embedded prefix, this was omitted in 50% of the times (2/4).

# Discussion

The present study is the first specifically investigating the nature of morphological errors in prefixed words. We compared, on the one hand, prefixed words with different stress patterns (verbs and nouns); on the other, prefixed nouns and pseudo-prefixed nouns, nouns with embedded stems, and nouns with embedded prefixes. In the accuracy rates, the only difference was that between prefixed verbs and nouns, which may suggest that words with unstressed prefixes are harder to retain; however, this could also be a word-class effect. As for the amount of constituent errors, this was comparable for prefixed verbs and nouns, indicating that stress pattern and word class are not relevant for this aspect. Prefixed and pseudo-prefixed nouns yielded more constituent errors than the other types of words. This may suggest that prefixed and pseudo-prefixed words are rather decomposed, while the others are treated as whole chunks. Interestingly, the majority of constituent errors with both prefixed verbs and nouns involved the stems instead of the affixes. This is striking considering that morphological errors, in the literature about suffixed words, generally involve the affixes, and it may be revealing of a difference in how prefixed and suffixed words are impaired. With pseudo-prefixed words and words with embedded stems or prefixes this was not case, since most errors occurred in the initial syllable; hence, this must have something to do with the morphological structure of the prefixed words. Finally, we investigated the type of error affecting the prefixes or the initial syllables. Prefixes in nouns, despite being stressed, were always omitted, while this only occurred with a minority of the (unstressed) prefixes in verbs, which were rather substituted. Even in pseudo-prefixed nouns and in nouns with embedded prefix, the initial portion of the word was rather substituted than omitted, suggesting that the many omissions of prefixes in nouns were caused by the morphological structure of the word.

In sum, the results complete the picture about morphological errors in deep dyslexia, investigating morphological errors with prefixed words. Errors with prefixed words seem to be morphologically grounded like errors with suffixed words; however, some observations point to a different error pattern from suffixed words. Further examinations with both prefixed and suffixed words are planned with NN in order to further investigate the nature of his errors.

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# Irony comprehension in right-frontal brain-damaged patients: the role of context

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## Introduction

Many right-hemisphere damaged patients experiment pragmatic impairments, affecting especially the processing of non-literal language, such as irony. Irony is defined as an utterance in which the intended meaning is different, and in some cases opposite, to the literal meaning. Last decades, several researchers have been interested in the cognitive aspects underlying pragmatic impairments, such as executive functions (inhibition, flexibility) and contextual processing (Martin & McDonald, 2003). Indeed, to understand an ironic utterance requires integrating different sources of contextual information (eg. contextual incongruity) to infer the intentional meaning of the speaker. The right hemisphere plays a crucial role in the holistic treatment of utterances. Therefore, it is possible that some RHD individuals process utterances locally rather than globally, leading them to opt for the literal interpretation of these utterances. However, no study has shown whether the difficulty manifested by RHD individuals in understanding irony comes from a lack of sensitivity to the context (difficulty in capturing or detecting relevant contextual information) or from an inability to integrate contextual information (correctly detected). It should also be noted that not all RHD individuals present such disorders and that different patterns of deficits exist among RHD individuals (Champagne-Lavau & Joanette, 2009; Coté et al., 2007).

Thus, the aim of this study was threefold: (1) to determine whether the degree of contextual incongruity influences the extent to which individuals with right-frontal-hemisphere damage understand irony; (2) to identify the disrupted process (detection versus integration of contextual information) leading to impaired irony comprehension; and (3) to identify potential different pragmatic profiles within the RHD group.

## Methods

Twenty individuals with right-frontal-hemisphere damage (RHD) and twenty healthy control (HC) participants matched for age and educational level were recruited. They were tested on neuropsychological measures (assessing cognitive flexibility, inhibition and working memory) and on their comprehension of irony. The latter was assessed through short written scenarios, ending with a literal or ironic target utterance. The context was manipulated to create three conditions: a literal condition, without incongruity between the context and the target utterance, and two ironic conditions, characterized by a weak or strong incongruity between the context and the target utterance. Participants were asked to read each of the 36 stories and then to answer a question about the speaker's intention ("What does X (the speaker) really mean?") and a control question about relevant contextual information needed to answer the first question (Champagne-Lavau et al., 2012).

To characterize different profiles, a hierarchical cluster analysis (Ward's method) was undertaken according to RHD performance on the task assessing understanding of ironic intent. Given the small sample size of each RHD subgroup, non parametric tests (Friedman and Wilcoxon test) were then performed to explore group differences on the irony task.

# Results

The hierarchical cluster analysis revealed an heterogeneous performance within the RHD group on pragmatic measures. On the one hand, 14 RHD participants (RHD-U (Unimpaired)) had similar performance to HC participants for the speaker intention's question: that is, more errors in the weak incongruity context condition than in the no incongruity context condition ($Z = -1.992$, $p = .046$) and the strong incongruity context condition ($Z = -2.522$, $p < .012$), but no difference between the no incongruity context condition and the strong incongruity context condition ($Z = -.516$, $p > .05$). On the other hand, six RHD participants (RHD-I) were impaired in their understanding of irony: they failed to identify the ironic intention of the speaker, regardless of the degree of the incongruity between the context and the target utterance (weak incongruity context condition = strong incongruity context condition ($Z = -1.604$, $p > .05$) < no incongruity context condition ($Z = -2.214$, $p < .027$)).

# Discussion

Our results are consistent with previous studies that demonstrated impairments in the comprehension of irony in some RHD individuals (Champagne et al., 2003; Kaplan et al.., 1990; Winner et al., 1998). This also confirms the known heterogeneity found after a right-hemisphere lesion (Champagne-Lavau & Joanette, 2009). Finally, they provide interesting insights into the processes underlying the deficits in understanding irony, especially the contextual processing. Indeed, the absence of a difference between the strong incongruity and weak incongruity context conditions in the RHD-I group suggests that the difficulty in understanding irony would be due to a lack of sensitivity to the contextual information rather than to a difficulty in integrating this information. RHD-I participants would use a local, analytic strategy to process the target utterance, leading them to opt most of the time for the literal meaning of the sentence (Cornejo et al., 2007).

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# Listen-In: High-dose home-based auditory comprehension therapy is achievable and effective – preliminary findings

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## Introduction

A significant challenge facing Speech and Language Therapists is providing a sufficient dose of impairment based therapy (Code, 2003). Gamification provides a potential opportunity to maximize dose by motivating patients to complete the recommended ~100 hours (Bhogal et al. 2003). Previous studies have suggested limited effectiveness for therapies aimed at alleviating auditory comprehension deficits in aphasia (Woolf et al. 2014, Maneta et al. 2001). However, one criticism of these studies is that they did not deliver a sufficient dose of therapy (Bhogal et al. 2003). We have developed a new tablet-based auditory comprehension therapy ('Listen-In'), which utilises gamification techniques with the aim of maximising engagement and therefore dose. We are currently testing the clinical efficacy of this novel rehabilitation application in a cross-over trial with 36 individuals with chronic post-stroke aphasia.

## Methods

### *Design*

We employed a randomized, cross-over design to test the effectiveness of Listen In against participants current 'standard care' (Figure 1). Participants completed a battery of assessments at five time points: baseline (T1), start of crossover (T2), crossover point (T3), end of crossover (T4) and follow-up (T5). At T2 or T3, participants completed a 12-week block of Listen-In therapy at home. This abstract presents preliminary findings from eight participants who have completed the crossover period to date.

### *Participants*

Participants had a mean age of 55 (SD=16), and were all more than 6 months post stroke (M=5.28 years, SD=4.67). All had impaired auditory comprehension on the Comprehensive Aphasia Test, on both spoken word comprehension (less than or equal to 25/30) and sentence comprehension (less than or equal to 21/32).

### *Outcome measures*

The main outcome measure was the comprehension section of the Comprehensive Aphasia Test (CAT) (Swinburn et al, 2005). The second outcome measure was the Auditory Comprehension Test (ACT). This test was specifically developed to investigate the efficacy of the Listen-In application. It was comprised of 220 spoken item to picture matching trials. The ACT test was divided into two sets in order to provide participants with a set of trained and untrained items (A and B, 110 trials in each set matched for frequency, syllable length and concreteness). During therapy, half the participants were exposed to Set A in the Listen-In application, and half to Set B. Allocation to sets was randomised.

### *Listen-In therapy*

At T2 or T3, participants completed a 12-week block of Listen-In therapy at home. This consisted of spoken word to picture matching on a tablet computer. Spoken words were presented in isolation, or in carrier phrases and sentences. Participants were required to listen to the target stimulus, and choose the matching picture. The recommended daily therapy dose was 1 hour and 20 minutes. Therapy was monitored remotely; if participants dropped below the recommended dose, they were contacted and asked to increase their dose.

# Results

Participants spent on average 83 hours (range: 33-95) on the therapy component over the course of 12 weeks, and 22 hours (range: 6-82) on the gaming component. There was a large amount of variation in the ratio of therapy to gaming time amongst participants.
We carried out repeated measures ANOVAs on the data so far to look at main effects of therapy on our two main outcome measures.
Participants showed no improvement on the primary outcome measure to date (Comprehensive Aphasia Test). Our secondary outcome measure (ACT) showed that participant's auditory comprehension of treated items improved after their block of Listen-In therapy. A 3 by 2 repeated measures ANOVA demonstrated a significant interaction between time point (baseline, pre, post) and treatment condition (treated, untreated); $F(2, 14)=37.55$, $p<0.001$. This interaction was driven by significant main effects for both treatment condition ($F(1, 7) = 12.12$, $p=.01$) and timepoint ($F(2, 14)=4.57$, $p=.03$). For treated items, a one-way repeated measures ANOVA revealed a main effect of time point ($F(2, 14) = 15.84$, $p<0.001$). This was driven by a significant difference between pre (M=55.90) and post therapy (M=68.75), but not between baseline (M=50.80) pre therapy. The same analysis for untreated items showed no main effect of time point ($F(2, 14) = 1.22$, $p=.33$).

# Discussion

These preliminary results suggest that the Listen-In app is effective in terms of both motivating participants to complete a sufficient dose, and improving auditory comprehension skills. Unlike previous intervention studies that have not shown improvements in auditory comprehension, the participants in this study were able to complete a very similar dose to that suggested by Bhogal et al. (2003) (98.6 hours) and improved on a measure of auditory comprehension. However, this improvement was for treated items only and did not generalise to untreated items, pointing to item-specific learning. These preliminary results suggest that intervention may need to target items of functional relevance to people with aphasia, either at an individual level, or by selecting items which are highly frequent in spoken language. We have demonstrated that delivering an intensive home-based auditory comprehension therapy is feasible and effective in improving auditory comprehension skills in post-stroke aphasia, within the setting of a clinical trial.
The Listen-In project is funded by the National Institute for Health Research's (NIHR) i4i research programme. This abstract summarises independent research funded by the National Institute for Health Research (NIHR)'s Invention for Innovation Programme (Grant Reference Number II-LB-0813-20004). The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.

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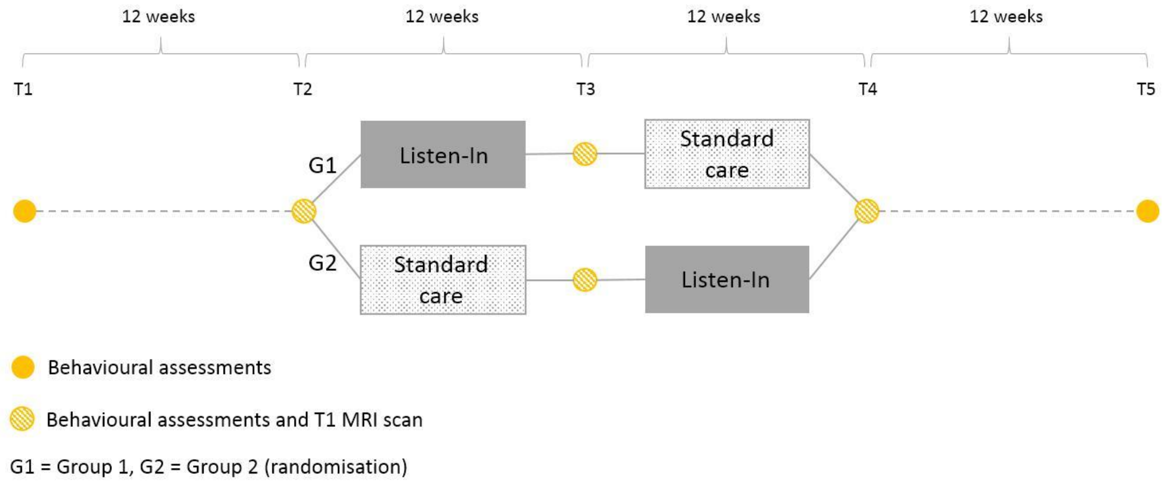

# Frequency of use and its influence on the reading of indigenous languages: Reading time reference violations in Shona

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## Introduction

In Zimbabwe, English is the high variety and the recognized main official language, whereas the major indigenous languages Shona and Ndebele are considered low varieties although they are now also recognized as official languages. The status quo has the effect that only a few people engage in reading and writing in the indigenous languages. To study the impact of this form of language usage, a study was designed to investigate how speakers of Shona read grammatical sentences and Shona sentences with grammatical and semantic violations. The reaction times and response accuracies on the processing of time reference violations were recorded.

## Methods

### *Participants*

Forty Shona native speakers took part in this experiment (20 male and 20 female). The age range was 19-30. The speakers had a minimum Ordinary level education qualification and they were evenly distributed over the four lists (5 male, 5 female in each list). All of them were right handed, had normal or corrected vision, they were right handed, no diagnosed neurological impairment or psychiatric disorder, and reported no usage of alcohol, recreational drugs or medications that could influence with their performance in the experiment.

### *Materials*

Each participant read 80 experimental sentences (40 with verb forms which do not match a time frame previously set by an adverb (past adverb-recent past tense; present adverb-remote past tense), 80 control sentences and 80 fillers, for examples see Table 1. The experimental sentences were presented in four conditions as illustrated in Table 1: correct sentences with an adverb preceding a verb, both referring to the past; violation sentences with an adverb referring to the past preceding a verb referring to the recent past; correct sentences with an adverb preceding a verb, both referring to the present; violation sentences with an adverb referring to the present preceding a verb referring to the past. Ratings on the plausibility of the sentences were obtained from 40 speakers of Shona offline who did not take part in the online study.

**Table 1.** Examples of the four experimental conditions.

| Condition | Adverb | | Verb | | |
|---|---|---|---|---|---|
| RemRem | Svondo rakapera | murwere | a**ka**pihwa | mapiritsi | nachiremba. |
| | Last week | the patient | was given | pills | by the doctor. |
| *RemRec | Svondo rakapera | murwere | **a**pihwa | mapiritsi | nachiremba. |
| | *Last week | the patient | has been given | pills | by the doctor. |

| | | | | | |
|---|---|---|---|---|---|
| RecRec | Nhasi mangwanani | murwere | **a**pihwa | mapiritsi | nachiremba. |
| | Today in the morning | the patient | has been given | pills | by the doctor |
| *RecRem | Nhasi mangwanani | murwere | a**ka**pihwa | mapiritsi | nachiremba. |
| | *Today in the morning | the patient | was given | pills | by the doctor. |

## *Procedure*

Participants were tested in a dimly lit sound-attenuated room sitting at approximately 80cm distance from a computer screen. Programming and presentation was done using E-prime (Psychology Software Tools Inc., 2002). The sentences were presented visually, word by word, in the middle of the computer screen, in black on white background, with 12 pt font size. At the beginning of each sentence an asterisk marking fixation point appeared for 500 ms. Each word was presented 500 ms, followed by a blank screen on the screen of the same duration. At the end of each sentence a blank screen appeared for 3000 ms, giving the participant time for any delayed responses. Participants were instructed to read each sentence carefully and to respond as soon as they detected an error by left clicking on the mouse. Sentences were presented in 4 blocks about 10mins each. At the end of the block participants were given a short break. The total testing time was about 40 mins.

# Results

On average, participants responded at chance (50%) both in the experimental and filler sentences.The results reveal the effects of not consistently engaging oneself in the indigenous language. The results are analyzed in the framework of the current language patterns of use by native speakers of Shona.

# Discussion

The current study focused on the reading of Shona. The findings demonstrate that to a large extent the negative attitudes towards indigenous languages due to inherited linguistic policies have encouraged the hegemony of English over indigenous languages. The fact that the participants could not consistently and accurately detect errors in written form but could do so with a higher level of accuracy in offline situations is consistent with limited exposure to reading in the language. The status quo has led to a vicious cycle and arguments that indigenous languages cannot be used for instance in teaching because of lack of resources in these languages, but this is a direct result of the neglect and hence underdevelopment (Kadenge & Nkomo, 2011).

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*Listen-In: Qualitative findings of involving people with aphasia in the development of a home-based auditory comprehension therapy application*

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# Introduction

Speech and language therapists have limited resources to provide a sufficient dose of impairment based therapy for people with post-stroke aphasia (Code, 2003; Bhogal, 2003). Some studies have utilised home-based computer programmes to maximise dose. However, sustaining motivation for intensive home-based self-administered therapy is a challenge. One potential way to encourage engagement and therefore maximise dose is by implementing gamification strategies into computer-based therapy. However, given that the majority of strokes occur in those aged over 50 (Stroke association) and the average age of gamers is 35 years (ESA, 2015), it is essential that any app implementing gamification with aphasia therapy is developed with the support of a sample of the population it is targeting. This study describes the involvement and contribution of people with aphasia (PWA) in the development of a tablet-based auditory comprehension intervention called *Listen-In*.

# Methods

Between six and ten people with aphasia were consulted in a series of five focus groups. Qualitative data was then analysed using a Thematic Content Analysis approach, and findings were used to drive changes to the application in an iterative process of development. The end goal was to develop a final product that was accessible and enjoyable to the population it was targeting.

## *Focus Groups*

Five focus groups (FGs) took place over a period of nine months, including two two-week periods of home-based play. FGs were led by one or two neutral facilitators from the communication disability charity Connect (Speech and Language therapists with experience working with people with aphasia). Research team members were present during the focus groups but did not participate in them directly. The FGs deviated in some aspects from traditional methodology in order to support participants communication. For example, subgroups were used to maximise the communication support available and minimise extraneous background noise. The typical format of each group was whole group introduction, followed by a split into two smaller groups, and then whole group feedback.

## *Data collection*

All focus groups were recorded in their entirety using two video cameras. We used traditional focus group methodology but implemented supplementary methods in order to adapt to the communication difficulties of this specific population. These supplementary methods included: supported conversation techniques, Visual Analogue Scales, closed yes/no questions, visual aids, and extrapolating/feeding back ideas from participants' responses.

### *Qualitative data analysis*

We employed a Thematic Content Analysis approach to establish key themes in user feedback which emerged from our focus groups. The data was analysed by three researchers using the qualitative software package *NVivo*. The process of analysis involved complete transcription of verbal and non-verbal communication in each video, the development of a coding framework, coding of the transcriptions, intercoder- reliability testing, and finally ‘theme assignment’. The data from each theme was then collated and summarised into ‘key findings and recommendations’. Pertinent findings were implemented into the app for subsequent prototypes and further focus groups.

## Results

### *The process of Running FGs with PWA*

Supportive communication techniques and extra time were vital to provide support and encouragement to participants and maximise effective communication. Despite expertise in running groups in this area, there remained a bias towards responses from members of the focus groups with greater expressive language skills. Data analysis was often challenging given the ambiguity of some non-verbal communication and inconsistent verbal responses. There was a large reliance on non-verbal communication during interpretation to disambiguate and support verbal transcriptions (e.g. gesture, facial expressions, tone). To further negate biased interpretations, inter-coder discussion and agreement was a key part of this analysis.

### *Feedback on the gamification*

The use and enjoyment of gaming strategies was variable amongst participants. A series of key themes emerged which impeded participant’s usability and enjoyment of the app. These included no overarching link between the therapy and gaming components, gaming features which were too easy/too difficult for different participants, and lack of understanding about the purpose of the game.

### *Feedback on the therapy*

Overall, participants were positive towards the therapy challenges, and only minor changes were suggested, such as including a wider range of stimuli. Participants demonstrated that they were able to use the therapy independently at home, and were sufficiently engaged to play for a period of two weeks. Background noise levels were enjoyed by participants and they felt it would be beneficial.

## Discussion

Involving PWA in the development of the *Listen-In* application presented with some challenges, which focussed on ensuring all participants were able to communicate their thoughts and ideas within the focus group setting. This study highlighted the changes which are needed to traditional methodology to support users with communication difficulties. In summary, our results provide evidence that involving PWA in the design and development of home based therapy is achievable and effective.

Collaborating with PWA in the focus groups allowed us to identify and modify barriers to usability and enjoyment. Several issues also arose which were not previously anticipated, highlighting the importance of involving the target population during development. The result of this process has been the development of a tablet based therapy which is sufficiently engaging to allow for 100 hours of independent home based practise.
The *Listen-In* therapy application is currently being tested for its clinical effectiveness in a randomised cross-over clinical trial of 36 PWA.

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# Targeting interhemispheric balance to modulate language processing: A tDCS study in healthy volunteers

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## Introduction

Transcranial direct current stimulation (tDCS) is a safe and tolerable brain stimulation method that has a high potential for routine clinical use to increase the gains of behavioral aphasia treatment (Galletta et al., 2016). However, it remains largely unknown which stimulation settings and targets provide the greatest therapeutic effect.
One hypothesis that may guide selection of stimulation settings is the interhemispheric competition hypothesis. It states that competition between the damaged left (language-dominant) hemisphere and the intact right (non-language-dominant) hemisphere may have a negative impact on language recovery in chronic post-stroke aphasia. In previous neuroimaging studies (e.g., Szaflarski et al., 2013), success of aphasia recovery in chronic stroke was often negatively correlated with right-hemisphere activation. While in the acute stage the right hemisphere may support language recovery, its role may become maladaptive in the chronic stage, preventing the perilesional areas in the damaged language-dominant hemisphere from successfully taking over linguistic functions (for a review, see Coqcuyt et al., 2017).
Informed by this evidence, brain stimulation treatments can attempt to modulate the interhemispheric balance of language-related activity in patients with chronic aphasia. Previous brain stimulation studies have shown language improvement after inhibitory stimulation of the right hemisphere (e.g., Kang et al., 2011; You et al., 2011; for a review, see Otal et al., 2015). But only a few studies have investigated whether the positive effect may be further enhanced by combining excitatory stimulation of the left hemisphere and inhibitory stimulation of the right hemisphere. Existing studies (Lee et al., 2013; Marangolo et al., 2016) have found positive effects of such bilateral stimulation. However, to the best of our knowledge, no studies have used both necessary control conditions, testing whether the effect of bilateral stimulation is superior to both excitatory stimulation of the left hemisphere only and to inhibitory stimulation of the right hemisphere only.
We aim to fill this caveat by investigating the effects of bilateral tDCS (the combination of anodal, supposedly excitatory, stimulation of the left hemisphere and cathodal, supposedly inhibitory, stimulation of the right hemisphere) in an experiment with both necessary control conditions. This is a study in the control group of healthy individuals without language disorders. It can provide baseline information on the effect of modulating the interhemispheric balance in normal language processing that can guide further research in patients with aphasia.

## Methods

### *Participants*

Data collection is currently in progress. Overall, we plan to test 60 healthy young individuals without any neurological/psychiatric conditions or speech/language disorders. All participants are right-handed and are monolingual native speakers of Russian.

### *Stimulation*

TDCS is delivered at 1.5 mA for 20 minutes via 25 $cm^2$ rubber-sponge electrodes using the Starstim® device, targeting the left inferior frontal gyrus (Broca's area or its right-hemisphere homologue). In a

between-group design, participants are randomly assigned to three stimulation conditions, 20 participants per condition:
(1) Bilateral condition: combination of anodal (supposedly excitatory) stimulation of the left hemisphere and cathodal (supposedly inhibitory) stimulation of the right hemisphere: anode at F7, cathode at F8;
(2) Control condition 1: only anodal stimulation of the left hemisphere: anode at F7, cathode at Pz;
(3) Control condition 2: only cathodal stimulation of the right hemisphere: cathode at F8, anode at Pz.
Every participant undergoes real stimulation on one day and sham stimulation on another day; the session order is counterbalanced across participants.

### *Stimuli and Tasks*

Participants perform two linguistic tasks, measuring word- and sentence-level processing: (1) written lexical (word/non-word) decision; (2) sentence comprehension task: participants read grammatically complex sentences in a self-paced mode and answer a comprehension question after each sentence by pressing a button to select one of two response options. Participants perform both tasks during stimulation (with small breaks) and are then tested on both tasks offline, immediately after the stimulation. Each offline session of the lexical decision task includes 60 words and 60 non-words, none of them repeated; the sessions are balanced for stimuli length and for lexical frequency and orthographic neighborhood of real words. Each offline session of the sentence comprehension task includes 60 sentences, none of them repeated; the sessions are balanced for sentence length, frequency of lexical items in sentences, question length, and length, frequency and grammatical gender of response options.

### *Data analysis*

Both accuracy and reaction times are analyzed in each task. The stimulation effect is calculated for each participant as the difference between his/her accuracy or mean reaction time in the real stimulation session and the sham session. A one-way ANOVA will be used to compare the stimulation effect in the bilateral stimulation condition vs. two control conditions.

## Discussion

Data collection is currently in progress. We hypothesize that bilateral stimulation (i.e., simultaneous excitatory stimulation of the left hemisphere and inhibitory stimulation of the right hemisphere) will provide the largest positive effect compared to the two control conditions, by most effectively directing language processing to the language-dominant hemisphere. The hypothesis will be tested separately for word- and sentence-level processing, since they may be lateralized to a different extent and thus show different effects of stimulation that targets the interhemispheric balance. This study in healthy individuals will provide baseline data that can inform further research in patients with aphasia.

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# Exploring impaired vs. spared learning performance in aphasia

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## Introduction

This study examined the cognitive-linguistic factors contributing to spared vs. impaired learning ability in post-stroke aphasia. Learning ability is essential for successful language (re)learning and recovery in aphasia (Kelly & Armstrong, 2009). However, only a small number of studies have explored learning in aphasia. These studies show that (a) learning ability is highly variable—but not universally impaired and (b) spared learning ability is associated with success in therapy (Dignam et al., 2016; Gupta et al., 2006; Vallila-Rohter & Kiran, 2013).

The cognitive-linguistic factors that support successful learning ability and recovery in aphasia remain undetermined. Previous studies have included brief cognitive screens, which fail to provide a detailed examination of cognitive performance. We propose that executive control abilities are an important factor, given that reduced executive control performance is associated with poorer therapy outcome (e.g., Fillingham et al., 2005).

Finally, most studies so far have utilised novel word learning paradigms. Further exploration utilising both novel and familiar learning material is necessary to better understand the factors that contribute to spared or impaired learning performance. The aims of this study are to (1) examine learning performance in aphasia using paired-associate learning of familiar words and unfamiliar novel pictograms, and (2) explore the cognitive and linguistic contributors to spared/impaired learning performance.

## Methods

### Participants

Ten participants with aphasia took part in the study ($M^{AGE}$ = 63.8, $SD^{AGE}$ = 8.12). All were at least two years post stroke and demonstrated non-fluent spoken output. Fourteen age and education matched controls also took part in the study ($M^{AGE}$ = 65, $SD^{AGE}$ = 7.69).

### Procedure

Cognitive-linguistic measures included a battery of executive control tasks adapted for individuals with aphasia. This included Stroop, Flanker, Switching, WCST, and N-Back tasks. For individuals with aphasia, language skills were assessed using the Comprehensive Aphasia Test. All Participants completed two paired associate learning tasks. For the first task, participants learned to pair words (e.g., tree—fork) and in the second task participants paired a word with novel pictogram. Participants were asked to learn pairs of items (i.e., to form an association between each). There were six learning blocks where participants were asked to observe and learn each pair (n=12 pairs). A test block was administered immediately after each learning block. During test, participants had to discriminate between correct and incorrect pairings (i.e., button press yes/no judgements about whether the pair had been seen during learning).

## Results

The control group successfully learned to discriminate between correct and incorrect pairs in both tasks by test block 6 (*Mean proportion correct responses for word-word task = .90 and word-shape* *task = .96*). For the aphasia group the learning tasks successfully discriminated between spared and impaired learning performance, and there was a significant correlation between performance on the two learning tasks (r = .893, $p$ <.001). We correlated learning ability (score at test block 6) with cognitive-linguistic measures. With regards to the executive control battery, learning performance correlated with spatial working memory (spatial n-back task) for both word-word (r = .736, $p$ = .015) and word-shape (r = .709, $p$ = .022) pairs. Learning performance also correlated with the Wisconsin Card Sort Task (WCST) on both the word-word (r = .803, $p$ = .005) and word-shape (r = .832, $p$ = .003) learning tasks. No other executive control measures correlated with learning performance. The only language measure to significantly correlate was verbal fluency, correlating with both word-word (r = .737, $p$ = .015) and word-shape (r = .66, $p$ .036) learning tasks. See figure for matrix of significant correlations.

# Discussion

Our results are in line with previous studies showing that learning performance is reduced in participants with aphasia, but not universally impaired. In order to examine the heterogeneity in learning performance, we examined cognitive-linguistic factors that might contribute to spared vs. impaired learning performance. We found that spatial working memory and WCST were positively associated with learning ability.

Previous studies have alluded to the role of spatial working memory in recovery in aphasia (e.g., Seniow et al., 2009). One explanation is that spatial working memory plays an important role in eliciting mental imagery during learning and therapy, in order to use semantic knowledge in a flexible and task appropriate way (Baddeley, 2003; Seniow et al., 2009). Additionally, the WCST has previously been found to correlate with therapy outcomes (Fillingham et al., 2005). Finally, language abilities (i.e., naming, comprehension, picture description) were a poor indicator of learning ability. Only verbal fluency—often considered an executive control measure—significantly correlated with learning.

These results highlight the importance of non-verbal cognitive performance for learning ability in aphasia. Given that learning is fundamental to successful therapy, these findings support the idea that non-verbal cognition has an important role in recovery, and future studies should aim to examine the broader cognitive profile of persons with aphasia.

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# Effects of prefrontal transcranial direct current stimulation on language production in post-stroke aphasia

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## Introduction

A successful interplay between prefrontal and domain-specific language areas has been shown to be crucial for language processing[1,2,3]. Non-invasive brain stimulation is increasingly being used as a promising therapeutic tool for neurological diseases.

The aim of the present study was to investigate the effects of excitatory transcranial direct current stimulation (anodal tDCS) of the dorsolateral prefrontal cortex on language production in chronic post-stroke aphasic patients. Using a randomized, sham-controlled and double-blind within-subject design, we expected an improvement of language production after left prefrontal anodal tDCS as compared to sham tDCS.

## Methods

### *Subjects*

14 right-handed, French speaking participants (mean age 57.7 ± 8.79) with chronic aphasia due to ischemic or haemorrhagic stroke (> 6 months post-stroke).

### *tDCS*

tDCS was applied for 20 minutes with a current density of 0.04mA/cm2, with the anodal electrode placed over the left dorsolateral prefrontal cortex and the cathodal electrode placed over the right supraorbital area. Each patient underwent one anodal tDCS and one sham tDCS session, with a one-week interval between the sessions.

### *Outcome measures*

A picture naming task, a repetition task, a verbal fluency task and a nonverbal executive functions task were performed both during (online) and immediately after stimulation (offline).

### Preliminary Results

A preliminary analysis shows that in the verbal (phonemic) fluency task, participants produced more words after anodal tDCS ($M$ = 6.5, $SD$ = 3.53) than after sham tDCS ($M$ = 5.5, $SD$ = 3.50), $t(13)$ = 2.65, *p* = .020, Cohen's $d_{av}$ = 0.28. However, results indicate no online effects as well as no effects in the picture naming, repetition and in the nonverbal executive functions tasks (all $p > .05$).

# Discussion

These preliminary results suggest that increasing prefrontal excitability might have beneficial after-effects on language production in aphasic patients. Importantly, our data show that this effect might be found only in tasks which depend on a strong interplay between language and executive functions, such as phonemic fluency.

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# Lexical Activation in Jargon Reading and Repetition

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## Introduction

Jargon aphasia is an acquired language disorder characterised by severe phonological deviations in word production. These deviations frequently give rise to nonwords errors, which are thought to occur when poor lexico-phonological processing allows non-target segments to override target phonology (Marshall, 2006; Olson, Romani, & Halloran, 2007). This hypothesis implies that words with lower resting levels of lexical activation will be more susceptible to error, given that they require greater activation input to reach processing threshold (Martin & Dell, 2007). Words with higher resting levels of lexical activation should demonstrate increased resilience against weak target activation and be less prone to error. However, aphasic case studies (including Jargon individuals) do not consistently show such effects (Ackerman & Ellis, 2007; Corbett, Jefferies, & Lambon Ralph, 2008; Nickels & Howard, 1995). Furthermore, the prevalence of sound/nonword errors in the Jargon population suggests that items weighing more heavily on phonological processing, for example multisyllabic words, would be most likely to disrupt phonological encoding. This study aimed to explore the effect of lexical variables (frequency, imageability, concreteness and familiarity) on Jargon production in single word reading and repetition.

## Methods

Seven individuals (five male) with fluent Jargon aphasia were recruited (age $M$ = 71.57, $\sigma$ = 9.81; months post stroke $M$ = 20, $\sigma$ = 10.5). For word reading, two separate word lists of 60 items were selected from the MRC Psycholinguistic database. One set contained "easy" words; higher frequency ($M$=86, $\sigma$ = 80.0), imageability ($M$=563, $\sigma$ = 48.75), concreteness ($M$=554, $\sigma$ = 51) and familiarity ($M$=556, $\sigma$ = 52.45) than the "hard" set (frequency: $M$=7.6, $\sigma$ = 6.59, p ≤ .001; imageability: $M$=408, $\sigma$ = 65.1, p ≤ .001; concreteness: $M$=365.7, $\sigma$ = 61.6, p ≤ .001; familiarity: $M$=422.9, $\sigma$ = 58.9, p ≤ .001). The word lists were matched for phonological properties including phonemic length (easy: $M$ = 5, $\sigma$ =1.74; hard: $M$ = 4.95, $\sigma$ =1.81; $p$ = .878) and syllable number (easy: $M$ = 1.83, $\sigma$ =0.86; hard: $M$ = 1.83, $\sigma$ = 0.87; $p$ = .752). For word repetition, the same statistical comparisons/values were upheld between the separate easy and hard word sets.
Participants were presented with a single word to be read aloud/repeated via Eprime, delivered on a laptop computer. Responses were not time pressured, however participants were prompted to move on following three incorrect attempts. Responses were transcribed using broad phonemic transcription in real time, and transcriptions were checked against an audio recording afterwards. All 60 items in each list were administered consecutively.

### Analyses

**Error analysis**

Responses were categorised as either a nonword or other (e.g. correct, unrelated real word or formal error) and a chi-squared test was used to compare nonword error rates on the easy/hard reading and repetition tasks.

**Phonological accuracy**

The accuracy of all responses was measured using the Phonological Overlap Index (POI): the number of phonemes shared between response and target x 2 / total number of phonemes in target and response (Bose, 2013). This calculation assigns all responses a value between zero and one, with zero reflecting no phonological overlap between target-response, and one indicating complete phonological overlap. Observed POI values on the easy and hard sets, per individual, were compared using t-tests. Reading and repetition were analysed separately.

# Results

## Error analysis

### Reading

Six individuals (1, 3, 6, 7, 8 and 9) exhibited no difference in the number of nonwords across the easy and hard reading tests ($\chi^2(1) \leq 3.077$, $p \geq .079$). Individual 4 produced significantly less nonwords in the easy reading set ($\chi^2(1) = 5.175$, $p = .023$).

### Repetition

Four individuals (3, 4, 6, and 9) showed no difference in nonword error rate ($\chi^2(1) \leq 1.637$, $p \geq .201$). Individuals 1, 7 and 8 produced less nonwords in the easy set ($\chi^2(1) \geq 6.988$, $p \leq .008$).

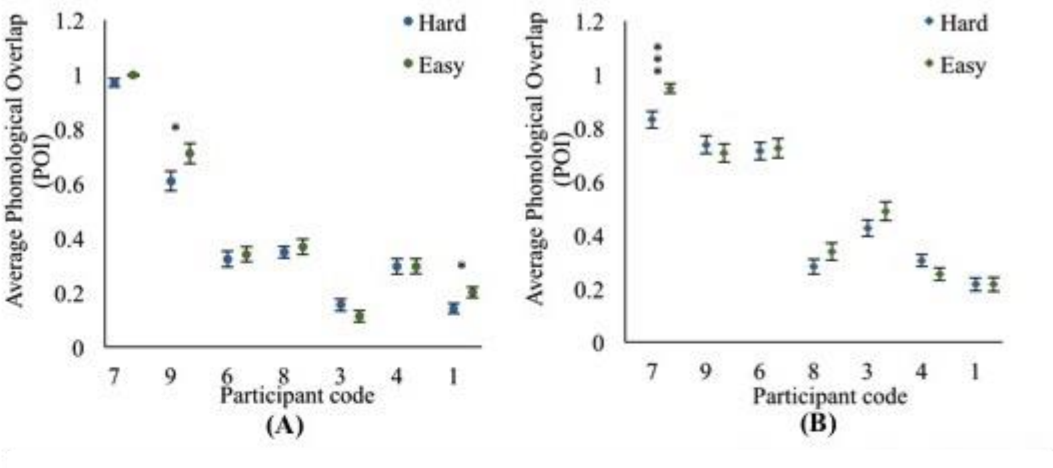
## Phonological accuracy

### Reading

Two individuals (1 and 9) produced greater phonologically accurate responses in the easy reading set ($p \leq .0268$; see Figure 1 panel A). Individual 7 showed a similar trend ($p = .078$). The remaining four individuals (3, 4, 6 and 8) produced similar rates of phonological accuracy in the easy and hard word sets ($p \geq .211$).

### Repetition

Individual 7 was more phonologically accurate in the easy repetition set ($M = .947$, $\sigma = 0.018$, $p = .001$). The remaining six individuals produced responses that were of equal phonological accuracy across easy and hard word sets ($p \geq .168$; see Figure 1 panel B).




*[figure 1]*

*Figure 1: (A) Average Phonological Overlap Index (POI) score per individual in reading.*
*(B) Average Phonological Overlap Index (POI) score per individual in repetition.*

*Note. Error bars show standard error, stars denote significance: * = p≤.05; **= p≤.01; ***=p≤.001.*

# Discussion

The main hypothesis accounting for Jargon aphasia posits that weak target activation allows non-target phonology to compete and intrude during lexico-phonological encoding. The current study aimed to explore this hypothesis by testing Jargon individuals on words that possess inherently higher/lower lexical activation levels, whilst controlling phonological processing demands. The majority of the group showed no difference in nonword error rates across the easy and hard word sets. In repetition, three individuals produced less nonwords on the easy set, however two of these individuals produced higher rates of other error types. Therefore, there was very little difference in overall error rates across the easy/hard sets. The Phonological Overlap Index (POI) measure demonstrated that, for the most part, there was no difference between the phonological accuracy of responses in the easy and hard word sets. This suggests that phonological encoding was equally disrupted in the easy and hard conditions, and indicates that lexical activation alone does not account for Jargon nonword errors. This implies that phonological processing demands, on which current word sets were matched, are a significant source of Jargon nonword errors in modalities involving both lexical and sub-lexical processing.

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# Specifying the underlying deficits in German patients with acquired dyslexia

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## Introduction

Since the pioneering work of Marshall and Newcombe (Marshall & Newcombe, 1973) sub-components of reading processes were systematically investigated within the theory of a cognitive dual route model of reading (Ferreres, Cuitiño, & Olmedo, 2005; Friedmann & Gvion, 2001; Miceli, Capasso, & Caramazza, 1994) and enables a systematic classification of acquired reading disorders. So far, there exists no theory-driven diagnostic tool in German language to assess reading performance in subjects with acquired dyslexia in detail. However, individual and resource-orientated therapy should be based on in-depth diagnostic assessment of reading performance. To fill this research gap we developed the model-based diagnostic tool *DYMO*.

## Methods

### *Participants*

Two dyslectic subjects (BL and EW) are described. Both were right handed monolingual German speaking men and had no reading or neurological deficits prior to stroke.

### *Materials*

*DYMO* comprises 16 tests to analyze routes and processing components of the cognitive model of reading: Graphemetical Analysis (with Letter-Identification, Letter-Position-Coding and Letter-to-Word-Binding), Graphemetical Input Lexicon (GIL), Semantic System, Connection between Semantic System and Phonological Output Lexicon (POL), POL, Phonological Output Buffer (POB), and Grapheme-to-Phoneme-Conversion (GPC, with Grapheme-Identification, Grapheme-to-Phoneme-Translation and Phoneme-Blending). Word material was controlled for different linguistic variables (e.g. frequency, length, word class, concreteness).

### *Procedure*

Reading performance of BL and EW was assessed at three to four consecutive sessions. Responses were recorded on audiotape for subsequent analysis. The primary outcome measure was reading accuracy; in a secondary step we analyzed error distribution, the influence of linguistic variables and the reading strategy. The predominance of phonological errors and regularization errors was classified as a segmental reading strategy, whereas the predominance of lexical, semantic errors and lexicalizations indicated a lexical reading strategy (Ablinger, Huber, & Radach, 2014).
All statistical analyses were performed using R, version 3.2.0 (https://www.r-project.org/).

# Results

BL showed no deficits in tasks of the Graphemetical Analysis. While lexical decision (classifying visual stimuli as words or non-words) was unimpaired, he was slightly impaired on word-pseudohomophone-decisions (accuracy 90%). BL was flawless in word reading; regularity, word class, word length, frequency and concreteness did not influence his word reading performance. BL showed no semantic deficits. He was severely impaired in finding antonyms from written stimuli, accuracy was at 65%. He showed a word-length-effect in reading non-words (accuracy 71%, short (80%) > long (50%), $p$ = .018), most of his errors were phonological errors. Accuracy in Grapheme-Identification was at 91%, in Grapheme-to-Phoneme-Translation at 77% and in Phoneme-Blending at 60% ($p$ = .029; post-hoc-analysis with bonferroni correction revealed only a difference between Grapheme-Identification and Phoneme-Blending: $p$ = .035).

EW showed no deficits in tasks of the Graphemetical Analysis. Lexical decision with words and non-words was accurate, whereas word-pseudohomophone-decisions were only possible in 73%. Word reading was influenced by regularity (regular (97%) > irregular (82%), $p$ = .025) and word class (function words (100%) > verbs (82%), $p$ = .027). Most of his errors were regularizations. Frequency and concreteness did not influence his reading performance. EW showed deficits in finding antonyms; accuracy was at 55%. When tested with the semantics of items from this task, accuracy was at 76%. Non-word reading was accurate in 90% of the items with no word-length-effect. Tasks of Grapheme-Identification showed 78% accuracy, Phoneme-to-Grapheme-Translation 91% and Phoneme-Blending 85%, performance did not differ significantly ($p$ > .05).

# Discussion

In the present study we implemented *DYMO* to assess acquired reading disorders in two German patients. At a first glance BL had exclusively difficulties in non-word reading, while EW showed the typical pattern of surface dyslexia with regularization errors and relatively good non-word reading. However, a systematic assessment with DYMO allowed a fine-graded in-depth analysis of their reading capacities. While lexical decision was flawless in both subjects, only a word-pseudohomophone-decision task revealed an impaired GIL. Thus, also in BL, whose word reading was accurate, the lexical reading route was slightly impaired. In the case of EW an impaired GIL corroborates the classification of surface dyslexia. This result is also in line with his semantic deficit, assessed in the antonym-generation task. In contrast to EW, BL´s difficulties in finding antonyms from written stimuli indicate difficulties in the access to POL when no written information is available.

EW showed regularizations on irregular words and a word-class-effect. Both error types point to an impaired lexical reading route; therefore, the non-lexical reading route is predominantly used. Additionally, non-word reading was relatively unimpaired in EW (90%). He did not show length-effects in word and non-word reading indicating an intact POB.

In BL, impairments in non-word reading resulted from difficulties in phoneme blending and an impaired POB indicated by the existing length-effect.

To sum up, *DYMO* enables a systematic assessment of lexical and sub-lexical word processing mechanisms to localize functional disorders in acquired dyslexia. In any case, an optimal model-based assessment of reading capacities supports individual approaches in reading interventions.

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# Individual variability and linguistic constraints on the comprehension of *wh*-questions in Turkish and German aphasia

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## Introduction

Previous studies have shown that individuals with aphasia (IWA) have particular problems comprehending *wh*-questions (e.g. Hanne, Burchert, & Vasishth, 2015; Hickok & Avrutin, 1996; Kljajevic & Murasugi, 2010; Martínez-Ferreiro, 2010; Nerantzini, Varlokosta, Papadopoulou, & Bastiaanse, 2014; Neuhaus & Penke, 2008; Salis & Edwards, 2008; Thompson & Choy, 2009; Thompson, Tait, Ballard, & Fix, 1999; van der Meulen, Bastiaanse, & Rooryck, 2005). According to some accounts, impaired comprehension of extracted object *wh*-questions in aphasia is due to the presence of overt *wh*-movement. However, other researchers have suggested that certain kinds of *wh*-questions are difficult for IWA in that processing costs that are required to parse discourse-related specifications cannot be met by IWA. Still others indicate that case marking plays an important role in IWA's interpretation of *wh*-questions. It is far from clear however which of these accounts can best explain IWA's comprehension patterns of *wh*-questions given the substantial amount of individual variability in aphasia. This study examines and compares IWA's comprehension of *wh*-questions in Turkish, a non-wh-movement language, and German, a *wh*-movement language.

## Methods

We examined a group of Turkish-speaking monolingual IWA (N=11, 2 females) and a group of German-speaking IWA (N=6, 2 females) using a picture-pointing task. In addition, 42 German and 56 Turkish non-brain-damaged (NBDs) individuals participated as a reference group. Our experimental stimuli contained 24 interrogative sentences in four conditions of Object-Which, Object-Who, Subject-Which, and Subject-Who questions. Each sentence stimulus was read aloud to the participants who were asked to answer the question by pointing to the person in a photograph that corresponded to the theme/agent of the situation being described (e.g. *Which woman is the man pulling?*) Mixed-effects regression models were used in group analyses and Random Forest models, a machine learning technique used for tree-structured non-parametric classification, were used to predict which individual and aphasia-related factors and which morpho-syntactic constraints best explain our data.

## Results

The data revealed that our Turkish IWA responded more accurately to Object-*Which* (73,4%) than to Object-*Who* (61,3%), Subject-*Which* (49,6%) and Subject-*Who* (50,7%) questions. They performed more accurately in Object-*Who* questions than in Subject-*Which* and Subject-*Who* questions. The German IWA, by contrast, responded more accurately to Subject-*Which* (62,0%) questions than to object-*Which (*38,4%*)*, Subject-*Who* (39,3%) and Object-*Who* (44,4%) questions. An interesting cross-linguistic pattern emerged in the Object-*Which* questions, which Turkish IWA had relatively fewer problems with whilst the German IWA were impaired; and in the Subject Which questions, which the German IWA had relatively little difficulty but the Turkish IWA failed comprehending.

Figure 1A depicts our predicting variables sorted by variable importance and Figure 1B shows the conditional binary inference tree for the Turkish IWA. Our Random Forest models indicate that aphasia severity, comprehension and naming profiles of the patients, the presence of *wh*-movement, and the presence of case-marking on the *wh*-pronoun were among the most informative variables in determining the IWA's selective difficulty on our task. Turkish IWA's comprehension patterns of *wh*-questions were predicted by aphasia severity and the presence of an accusative case morpheme on the *wh*-words. However, the German IWA's response accuracy was predicted by the presence of *wh*-element in nominative form (i.e. due to their better performance in subject questions) and the lack of *wh*-movement.

# Discussion

We suggest that IWA's comprehension difficulties in *wh*-questions cannot fully be accounted for from a single point of view of the hypotheses that predict the presence of *wh*-movement or discourse-related specifications make *wh*-questions vulnerable in aphasia. Therefore, an amalgamated view needs to be adopted. We have shown that linguistic features such as case marking or canonical ordering of thematic roles provide cues that IWA tend to rely on during their comprehension. However, reliance on such cues is modulated by individual factors.

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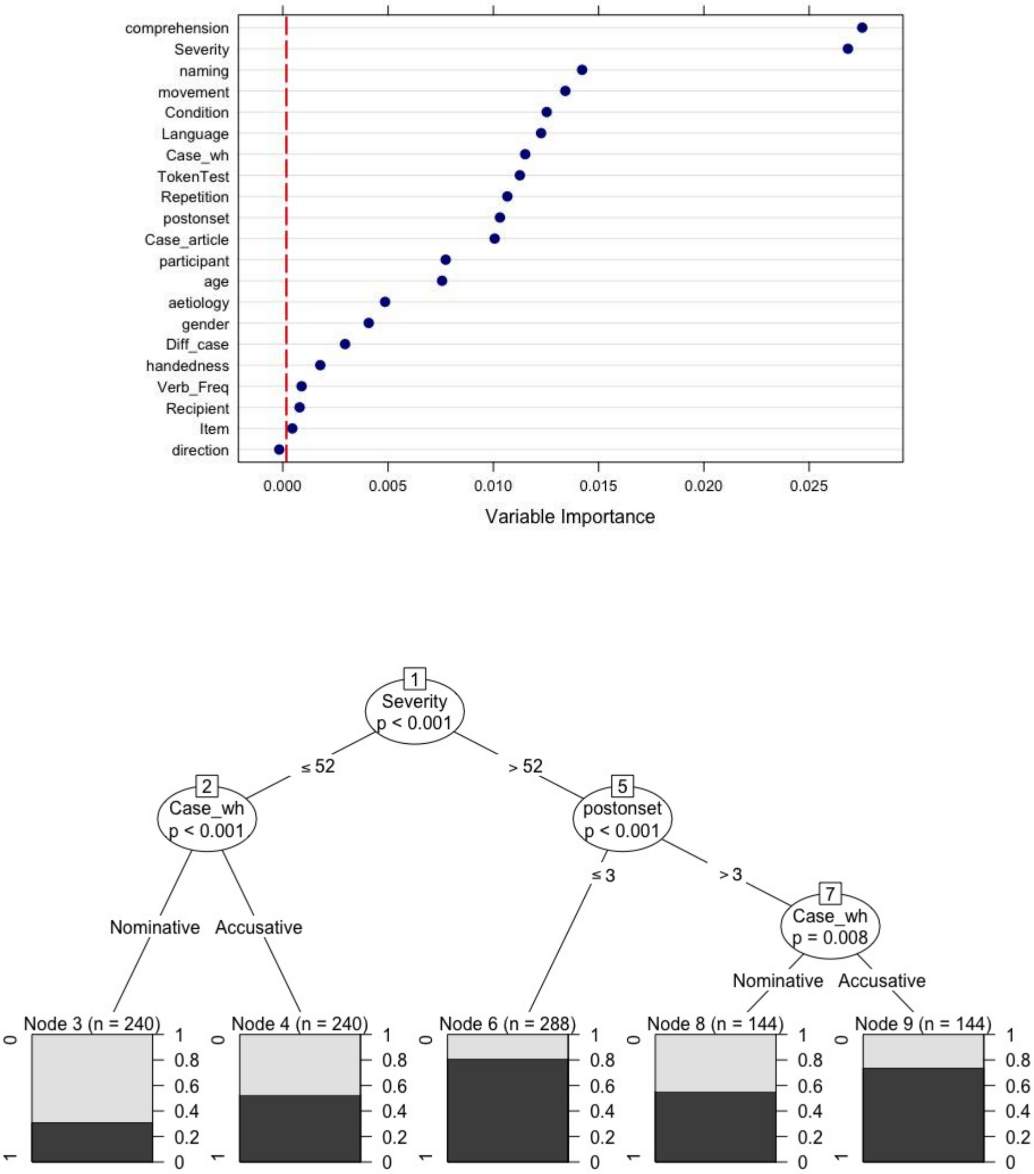
*Figure 1**A***. Predicting variables sorted by variable importance (higher ranking indicates more informative variables). *1**B.*** The best conditional binary inference tree for the Turkish agrammatic speakers' comprehension of *wh*-questions (Severity = combined scores of aphasia severity; Case_wh = type of case morpheme appended to the *wh*-element (accusative vs. nominative); postonset = months since the induction of aphasia).



# Core regions for syntactic processing?

# A tDCS study on the language network.

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## Introduction

Many questions are still open for language processing (Hagoort, 2014), such as the role of specific language properties (phonology, syntax and semantics) for the definition of the language network and if processing language properties requires focal activation of a specific area. In the past years several techniques have been allowed a deeper investigation to further detail the brain network relevant for language processing. In this study, we used transcranial direct current stimulation (tDCS) to temporarily inhibit Broca's area (BA 44/45) in a group of healthy participants, while a sentences comprehension task was carried out. A second group of participants received the same stimulation in the temporal area (BA 22) of the left hemisphere, during the same comprehension task. The main aim of this study was to clarify the role of these two language network hubs, Broca's area and BA 22, for syntactic processing, focusing on the impact of its disruption for comprehension of sentences with different degrees of syntactic complexities.

## Methods

### *Participants and materials*

33 English-speaking adults (MCA 22, sd. 2.37) participated in the study. All participants were tested prior to the stimulation on both grammatical comprehension (TROG-2; Bishop, 2003) and verbal digit span (Wechsler, 2010) to control for differences in language abilities in the two groups and to guarantee a standard performance on grammatical reception. After completing these measures, participants were randomly allocated to one of the two active experimental conditions. Group A received cathodal stimulation on Broca's area and the reference electrode was positioned on the temporal area, while group B had the same montage with opposite polarities. Areas for bicephalic unilateral montage were identified through the EEG 10-20 system (Jasper H.H., 1958). All participants also participated in a sham (control) session. Order of cathodal-sham sessions was randomized.
tDCS was delivered through a TCT Research tDCS 1ch stimulator (2012 TCT Research Limited, Hong Kong) and 2 5 by 5 cm rubber-sponge electrodes. Parameters were set at: 2mA intensity, 10 minutes duration, with a 15 second ramping up/down period at the start and end of the stimulation (cathodal stimulation) (Fregni et al. 2014). The sham condition uses the same parameters but the stimulator automatically turns off current after 30 seconds.
During both stimulation conditions (online stimulation), participants performed a true value sentence-picture comprehension task. The test was developed with Psychopy and comprised 40 reversible sentences divided in 4 syntactic structures, with increasingly syntactic complexity:
Simple active: The boy is chasing the grandma.
Long coordination: The boy eats a banana and the cat drinks some milk.
Peripheral object relatives: The girl hits the boy that the mum is kissing.
Centre embedded object relatives: The girl that the boy is pushing is looking at the dog.
Items and pictures were adapted to English from the Italian sentence comprehension standardised battery "Comprendo" (Cecchetto, C. et al., 2012). Time for each session was adapted to tDCS duration and fixed. The Serial Visual Presentation formula was used to calculate fixed reading times for each sentence (Otten & Van Berkum, 2008).

After presentation of a sentence within the fixed time, a blank screen with a fixation cross lasting 500ms was displayed, followed by the picture (6 seconds fixed interval) with correct or reversed roles. Total time of the session was 10 minutes during both experimental conditions and sham conditions.

### *Results*

Both accuracy and reaction times (RTs) were collected. We did not expect differences in accuracy in relation to stimulation, given the sample composed by healthy participants and the task difficulty. As such, accuracy is used to confirm task reliability, while RTs are used to test the experimental hypothesis. All participants performed accordingly to the syntactic complexity, with active sentences being characterized by less errors and the center-embedded object relatives sentences being presenting with a higher number of errors. A mixed ANOVA was performed on RT with the Group (cathodal Broca, cathodal Temporal) as between subjects factor and Type of Sentence (simple active, long coordination, peripheral object relative and center-embedded object relative) and Type of Stimulation (sham vs tDCS) as within subjects factors. Effect size was computed as partial eta squared ($\eta 2_p$). We found a main effect of Type of Sentence ($F_{(3,93)}$ = 191.391; p < .001, $\eta 2_p$ = .86) and a significant interaction between Group and Type of Stimulation ($F_{(3,93)}$ = 5.005; p = .033, $\eta 2_p$ = .14) (Fig. 1).
The main effect of Type of Sentence confirmed a significant increase of times in each sentence types independently form the type of stimulation received and the area stimulated. The interaction, further explored by means of estimated marginal means comparisons Bonferroni corrected, revealed that the effect is driven by a significant increase in all sentence types in the group receiving cathodal stimulation to Broca's area (mean difference: = .304 seconds, p = .022), while no differences emerged in the two groups during sham stimulation (mean difference: = .019 seconds, p = .886).

## Discussion

A variety of research has demonstrated that Broca's area (particularly pars opercularis. BA 44) is activate during verbal working memory tasks, with some research suggesting that Broca's area does not have any language specific functions instead supporting language processing in non-specific ways (Thompson-Schill SL, Bedny M, Goldberg RF., 2005). In this study, we show that inhibiting Broca's area during a syntactic comprehension task has a general effect on sentences even of different difficulty, causing an increase in the time required to map grammatical roles compared to the same inhibition on the temporal area.
Our results are in agreement with studies showing how Broca's Area is involved in processing of grammatical knowledge, in line with what reported also for implicit grammar tasks (De Vries, et al., 2010). Furthermore, the study supported the specificity of these effects to Broca's area and its core functional engagement for supporting syntactic processing with no involvement of the left temporal area for core processing of syntax. We conclude that Broca's area is specifically involved in syntactic based processing, and here with pejorative effect of detecting grammatical roles.

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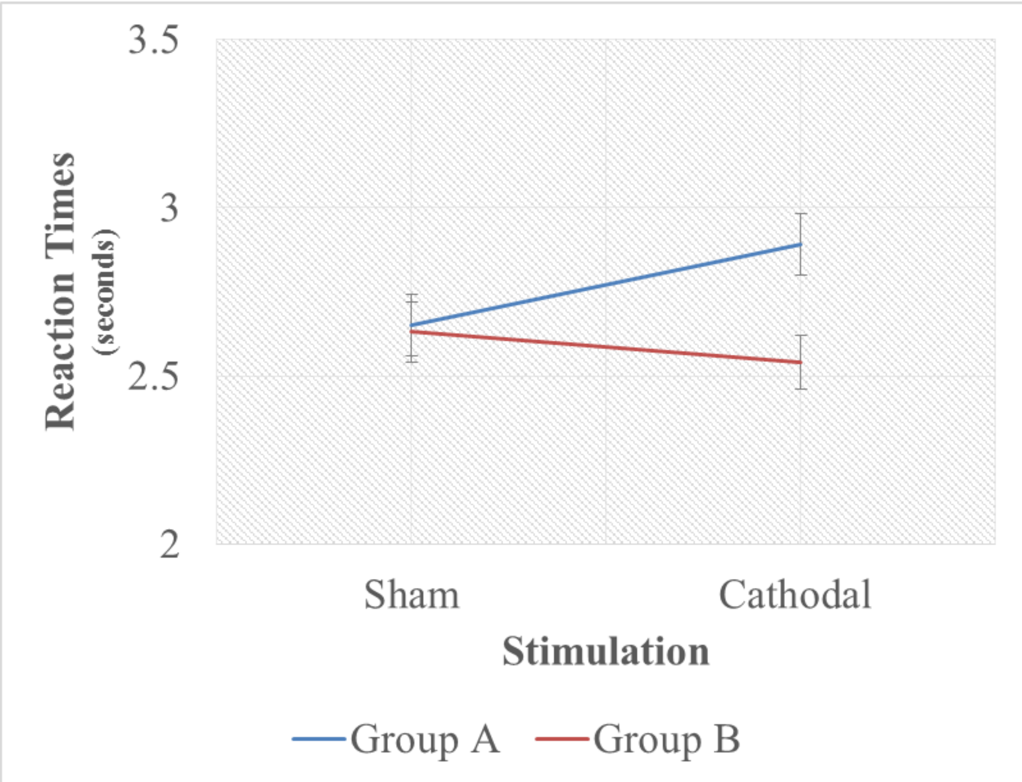


**Figure 1**. RT (seconds) for Group A (Broca's cathodal) and Group B (Temporal cathodal) as a function of stimulation type (sham versus active). Error bars show standard error of the mean. The figure shows how performance changes dramatically when Broca's area is inhibited.

# Effects of attentional and lexical cues on syntactic production in aphasia: eyetracking-while-speaking

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## Introduction

Impaired sentence production is pervasive in individuals with aphasia (IWA). Existing studies attribute this deficit to desynchronized lexico-syntactic integration secondary to reduced processing resources (Kolk, 1995; Linebarger et al., 2000). However, translation of this knowledge into clinical practice has been challenging because little is known about what information drives message-structure mapping most effectively in IWA. Decades of psycholinguistic research have revealed that the normal sentence production system opportunistically uses both word- and structure-level information to ease lexico-syntactic integration processes (Bock & Ferreira, 2014). In word-driven production, speakers incrementally build sentence structures as they speak based on the relative ease of retrieving individual words (e.g., attentional saliency, lexical accessibility). In structure-driven production, in contrast, availability of a larger relational structure among elements (e.g., verb argument structure) drives sentence production: speakers begin their speech upon having already prepared (or having a 'look-ahead' of) the overall relational structure among words.

Little systematic research is available on how different types of information accessibility influence syntactic production in IWA. Recent eyetracking sentence production studies have shown that access of verb argument structure information before speech onset is facilitative of sentence production in IWA, in line with structure-driven production (Lee & Thompson, 2011a; 2011b; Lee, Yoshida, & Thompson, 2015). However, it remains an open question if the aphasic language production system also follows word-driven incremental production, opportunistically using word-based cues to ease syntactic production. In this on-going study, we examine the effects of attentional (Experiment 1) and lexical priming (Experiment 2) on speakers' choice of alternating sentence structures, using an eyetracking-while-speaking paradigm.

## Methods

### *Participants*

The data from 16 young controls and 5 participants with mild-to-moderate aphasia have been analyzed so far for both experiments.

### *Materials and Procedure*

Experiment 1 examined the effect of attentional priming on the production of sentences with perspective verbs (*the man is fleeing from the dog/the dog is chasing the man*) and those with conjoined noun phrases in a picture description task. Attentional saliency of alternating characters in a scene (agent/theme) was manipulated by presenting a brief attention capture cue (a red dot, $r$ = 25 pixels) for 100 ms prior to the target picture. The position of the attention cue varied across trials, once appearing on the position of the preferred (*man*), and once appearing on the position of the non-preferred (*dog*) subject for each target picture.

Experiment 2 examined the effect of lexical priming on the production of sentences with dative and transitive alternations. The relative ease of lexical retrieval for the critical nouns was manipulated based on the 'givenness' of the nouns in the auditory probe sentence. For dative alternations, the agent and theme (*what is happening with the <u>man</u> and the <u>ball</u>?*) vs. the agent and goal (*what is happening with the <u>man</u> and <u>woman</u>?*) was primed in the probe sentence to elicit the prepositional dative (PD) (*the man is throwing the ball to the woman*) vs. double objective (DO) (*the* *man is throwing the woman the ball*) targets respectively. For transitive alternations, the agent (*what is happening with the man?*) and the theme (*what is happening with the boy?*) was primed for the active (*the man kicked the boy*) vs. passive (*the boy was kicked by the man*) targets respectively.

It was reasoned that speakers would show increased likelihood of producing the structure that allows earlier production of the primed element if participants follow word-driven incremental production (*the man is fleeing from the dog* instead of *the dog is chasing the man* when the 'man' is primed in Expt 1). Thus, for off-line production data, we measured proportion of preferred sentence structures produced under preferred vs. non-preferred primes. Participants' eye fixations to each characters in the visual scene were also recorded during picture description. They served as indices of successful priming effects on the moment-by-moment processing of the visual stimulus, as measured by earlier fixations to the primed character over the unprimed character.

# Results

In Experiment 1, young controls showed significant priming effects during off-line sentence production, producing preferred characters in the subject position more frequently under the preferred rather than the non-preferred priming condition (65% vs. 56%, $p < .01$). However, for IWA, the priming effects were not reliable (60% vs. 50%, $p >. 05$). For the eye fixation data, both groups made earlier fixations to the primed character than to the unprimed character (controls: 69% vs. 30%; IWA: 73% vs. 30%, *p*'s < .01), indicating that the attention capture primes successfully drew IWA's visual attention to primed characters.

In Experiment 2, both young controls and IWA produced preferred structures (PD, actives) more frequently when the preferred lexical items (agent and theme for datives; agent for transitives) were primed, compared to when non-preferred lexical items (agent and goal for datives; theme for transitives) were primed (controls: 84% vs. 20%; IWA: 77% vs. 48%, *p*'s < .01). For the eye fixation data, both groups again showed significantly earlier fixations to the primed than the unprimed character (controls: 62% vs. 34%; IWA: 64% vs. 39%, *p*'s < .01).

# Discussion

Our young healthy speakers showed clear attentional and lexical priming effects on their production of sentences, consistent with word-driven incremental production (Gleitman et al., 2007; Slevc, 2011). IWA showed normal priming effects on eye fixation data in both experiments, suggesting that both attentional and lexical primes were effective in successfully drawing visual attention to different characters, thus activating the primed word earlier than the non-primed word. However, only lexical primes and not attentional primes successfully modulated aphasic speakers' choice of sentence structures. Taken together, these findings suggest that aphasic speakers have preserved ability to incrementally plan sentences, taking advantage of relative accessibility of lexical items. However, the aphasic sentence production system may not be as radically incremental as the sentence production system in young healthy speakers, as evidenced by greater priming effects with linguistic (lexical in the current study; structural in previous studies) compared to non-linguistic cues. We will discuss further clinical and theoretical implications on the relation between sentence production processes and speakers' cognitive-linguistic capacity.

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# Prepositions in Transcortical and Mixed aphasias

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## Introduction

Prepositions form closed classes, but have nevertheless traditionally been analysed as lexical items on a par with nouns, verbs and adjectives. Some research suggests that in reality prepositions are a hybrid category comprising both grammatical and lexical items. In formal linguistics a split has been made between forms with a high semantic content that assign theta-roles and those reduced to a grammatical role, case assigners with low-to-vacuous semantic content unable to assign theta roles (Rauh, 1993; Tremblay, 1996; see Littlefield, 2005 and references cited therein). Syntactic and semantic properties are at the core of this distinction. In a recent functional theory (Boye & Harder 2012), grammatical and lexical items, including prepositions, are distinguished based on prominence: grammatical prepositions are discursively secondary, as opposed to lexical words that can be discursively primary, i.e. express the main point of an utterance. It follows from this that only lexical prepositions can be focalized and addressed in subsequent discourse. Criteria for grammatical prepositions are thus lack of focalizability and addressability.

These distinctions between grammatical and lexical prepositions received support from different psycholinguistic, language acquisition and clinical linguistic studies. Prepositions have been reported to be susceptible of damage in aphasia and frequently omitted in agrammatism (Menn & Obler, 1990). Interestingly, omissions have been traditionally described as a “grammatical morpheme deficit”, despite linguistic theories classifying prepositions as lexical items (Goodglass et al., 1970; Druks, 2016). Despite the scarcity of works examining the heterogeneity of prepositions (see Mätzig, 2009 for a review), some studies have shown consistent differences across individuals with Broca’s and Wernicke’s aphasia (Friederici, 1981, 1982, Bennis et al. 1983). Friederici (1981) studied the performance of American English speakers. Prepositions were found to be more severely impaired in Broca’s than in Wernicke’s aphasia. However, the performance of Broca’s informants improved in contexts of “semantically based processes” (Friederici, 1981: 197). On a later study in German, Friederici (1982) showed that informants with Broca’s aphasia were better at producing lexical than grammatical prepositions (69.6% vs. 36.3% correct). The opposite pattern was found for informants with Wernicke’s aphasia, who correctly used lexical prepositions less than grammatical prepositions (51.79% vs. 63.1% correct). This was also the case in Bennis et al.’s (1983) study of Dutch. Participants with Broca’s aphasia were found to be better at producing lexical prepositions than grammatical prepositions in a sentence completion task.

In this study, we aim at providing further evidence for the lexical-grammatical divide of prepositions in a set of Spanish-speaking individuals with rarely investigated aphasic syndromes: transcortical and mixed aphasias. We hypothesize that, as the speakers of Germanic languages with Broca’s and Wernicke’s aphasia, Spanish-speaking informants classified as non-fluent will show deficiencies in their use of grammatical prepositions, while individuals with fluent deficits will experience more difficulties with lexical forms.

# Methods

## *Subjects*

We focused on the performance of 9 Spanish-speaking individuals with aphasia (IWAs) from the Rosell (2005) corpus: 2 diagnosed with transcortical motor aphasia and 7 diagnosed with mixed aphasias (4 with motor predominance and 3 with sensory predominance). The non-fluent group included 3 males and 3 females (mean age = 65.6) and the fluent group included 3 males (mean age = 64). The performance of an additional set of 15 matched individuals (9 males, mean age = 58) was also analyzed.

## *Corpus data & Analysis*

Data was obtained by means of semi-standardized interviews (last job and last holidays). Samples of 300 words per participant were transcribed and analyzed. All prepositions were counted and all tokens classified as lexical and grammatical departing from Stewart's (2015) classification of Spanish prepositions and applying Boye and Harder's (2012) criteria. A total of 825 forms were included in the analysis. These consisted of 7 different lexical forms (n = 203 items: *desde* "since, from", *durante* "during", *en* "in", *entre* "between, among", *hasta* "until", *sin* "without", *sobre* "on, about") and 5 different grammatical forms (n = 622 items: *a* "to", *con* "with", *de* "of", *para* "for", *por* "for, by"). Quantitative results were analyzed using IBM SPSS Statistics 24.0.

# Results

The results show a clear divide between grammatical and lexical prepositions. First, grammatical prepositions are more frequent in the speech output of the all informants in the aphasia (fluent and non-fluent) and the non-brain-damaged (NBD) groups. Differences were significant for NBDs (Wilcoxon: Z = -3.413, p = .001) and non-fluent individuals (Wilcoxon: Z = -2.201, p = .028).

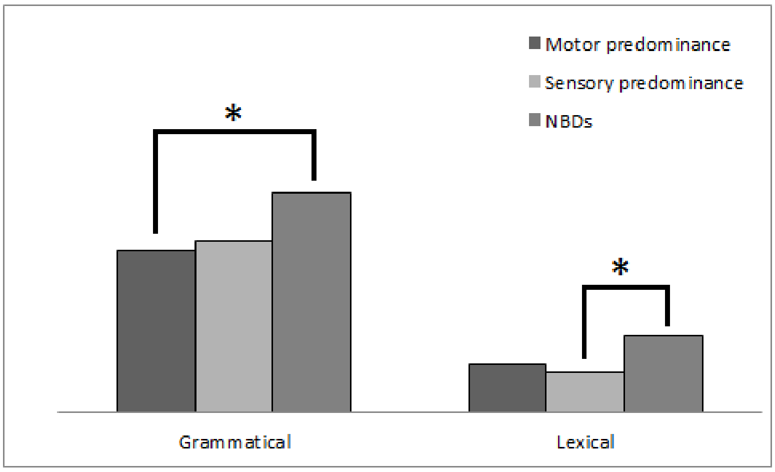


Figure 1: Grammatical and Lexical prepositions.

Across groups, opposite patterns were found in the performance of fluent and non-fluent IWAs. While fluent individuals were found to produce significantly less lexical forms than their control counterparts (Mann Whitney: U = 4.5; Z = -2.151, p = .027), no differences were found for grammatical forms (Mann Whitney: U = 8.5; Z = -1.668, p = .100). As for non-fluent informants, these were found to produce significantly less grammatical forms than controls (Mann Whitney: U = 14.5; Z = -2.384, p = .014), and showed no differences for lexical forms (Mann Whitney: U = 23; Z = -1.737, p = .095).

## Discussion

Despite etiological differences in our sample of IWAs, our results are consistent with previous findings from informants with Broca's and Wernicke's aphasia (Friederici, 1981, 1982, Bennis et al., 1983) and show that the grammatical-lexical asymmetry is not restricted to these syndromes, but general to fluent vs. non-fluent aphasias. These findings are relevant both from a theoretical and a clinical perspective. First, they confirm the heterogeneity of prepositions, which should no longer be analyzed as a monolithic category. Consequently, their status in the assessment, diagnose and treatment of aphasia should be reconsidered.

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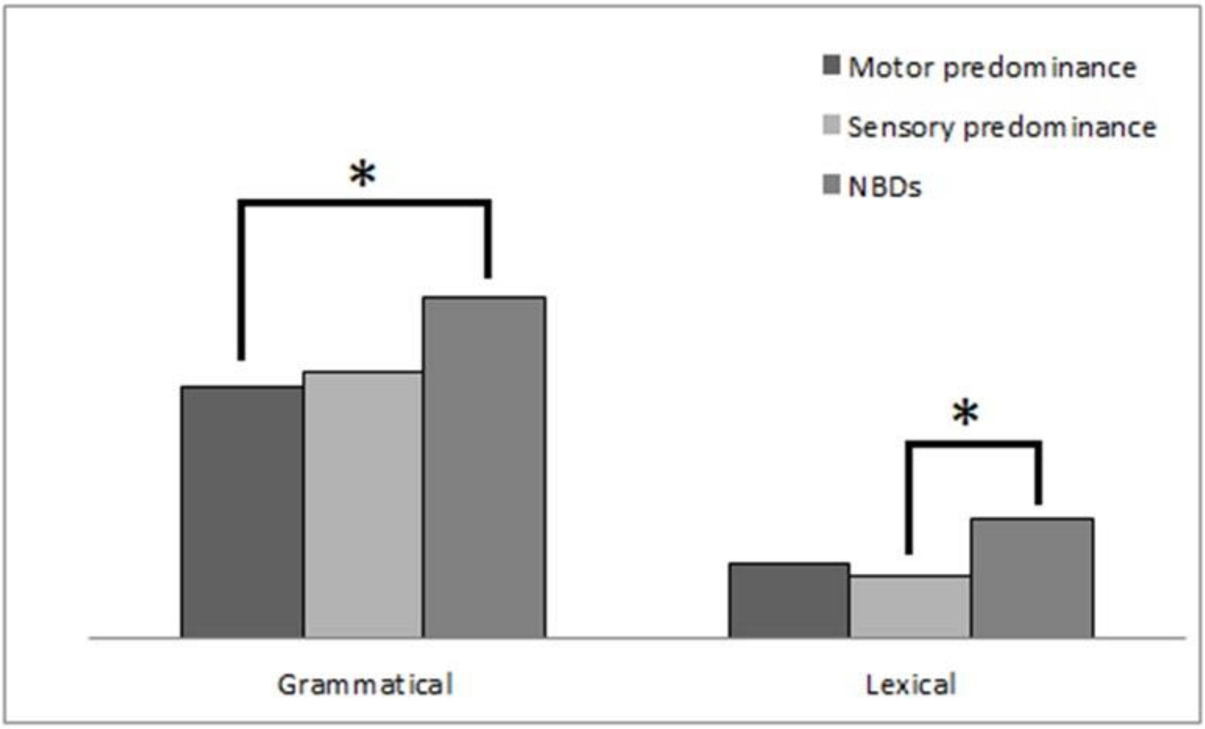
Motor predominance
Sensory predominance
NBDs
*
*
Grammatical
Lexical

# The influence of emotional valence on word recognition in people with aphasia

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## Introduction

People with aphasia frequently have difficulties in understanding and producing single words, with performance affected by a range of psycholinguistic variables, including word length and frequency. This study considers the effects on lexical processing of using emotionally valenced words: words that evoke an emotion but do not directly label one (e.g. negative valence = *poison*, positive valence = *peace*). Studies of neurotypical adults have found that emotional valence may also affect lexical processing efficiency (Kousta, Vinson & Vigliocco, 2009). It is possible that emotional valence is therefore an additional psycholinguistic variable that influences performance for people with aphasia, with implications for assessment and materials used in intervention.
The current study therefore aimed to investigate the effects of emotional valence on single word processing in people with aphasia. People with and without aphasia completed written lexical decision task, in which emotional valence was manipulated.

## Methods

### *Participants*

Forty people took part in this study, 20 people with chronic aphasia (age range: 36-83) and 20 age, education and gender matched neurotypical controls. Both groups comprised 10 men and 10 women. The participants with aphasia were recruited from a community clinic in London and were at least six months post-stroke. This group had differing communication difficulties, with varying levels of severity as assessed by the Western Aphasia Battery (Kertesz, 2006). The majority of participants presented with anomic aphasia (15/20) and Aphasia Quotient scores indicated severity ranging from 46% to 96.8%.

### *Stimuli*

Stimuli were adapted from those used by Kousta at al. (2009). There were 228 items in total:

- 114 words: 38 negative, 38 positive and 38 neutral words which were matched in terms of emotional valence, arousal, concreteness, imageability, age of acquisition, familiarity, frequency, orthographic neighbourhood, number of letters, syllables and morpheme and mean positional bigram frequency.
- 114 non-words: 38 additional negative, positive and neutral words were also selected, which were matched to pair with another word by length. One letter was then changed to create non-words that were pronounceable and orthographically licit.

Two items and their associated pairs from the original set used by Kousta et al (2009) were excluded from the current item set because they provoked responses below chance level in the previous study.

### *Procedure*

Participants were tested individually, and the lexical decision task was presented via computer. At the start of each trial, a fixation cross appeared in the centre of the screen for 800ms, followed by a letter string (either a word or a non-word) with a tick and cross symbol which remained on screen until participants made their response. No time limit was set for registering a response as it was anticipated that the group with aphasia would require longer to respond. There was a blank inter-trial interval of 1000ms. The stimuli were presented in a randomised order and participants were unable to self-correct errors. The computer program used to present the stimuli recorded response times and response accuracy per letter string.

## Results

In order to remove the influence of anticipatory responses or attention lapses for reaction time data, incorrect responses, responses below 150ms and responses that deviated above 3 standard deviations from the mean were excluded from analysis. Mixed ANOVAs were used to explore the effects of group and valence on accuracy and response time in the lexical decision task.

For accuracy, the ANOVA revealed that those with aphasia performed significantly less accurately than control participants. Across the whole group, accuracy was significantly higher for words with positive valence than for negative and neutral valence. A significant interaction was found between emotional valence and group, which revealed that participants with aphasia scored significantly more accurately for words with positive valence, but for the controls no significant differences were found between valence types (see Figure 1).

The second ANOVA exploring response time revealed that the participants with aphasia took significantly longer than the control group to respond. Participants across the whole group responded significantly more slowly to neutral stimuli. In this case there was no significant interaction between group and valence, but further analysis indicated that the participants with aphasia were quicker at responding to positively and negatively valenced words over words with neutral valence. Control participants responded more quickly to words with positive valence.

## Discussion

Participants with aphasia performed significantly more poorly than the neurotypical controls, in line with previous studies using lexical decision (e.g. Moreno, Buchanan & Van Orden, 2002). Key differences in response to emotional valence were observed between those with and without aphasia, though there appears to be a facilitatory influence of positively valenced stimuli for both groups.

For the neurotypical control participants emotionally valenced words only showed a processing advantage in terms of response time and only positively valenced words provoked a significantly quicker response. This contrasts with previous research with neurotypical adults (Kousta et al., 2009), though this may be the result of marked differences in the ages of participants in the two studies (mean age in this study: 61.5; in Kousta et al (2009): 19.15 years).

For people with aphasia, a processing advantage was observed for emotionally valenced words over neutral words. These findings mirror previous research in word recognition in aphasia (e.g. Landis, 2006). However previous studies have not considered the effects of whether words were positively or negatively valenced. The findings of this study suggest words with positive valence may be more accurately processed than those with negative valence, indicating the importance of categorising words by polarity.

These findings indicate that emotional valence is an important psycholinguistic variable that should be considered when designing assessment and intervention programmes for individuals with aphasia.

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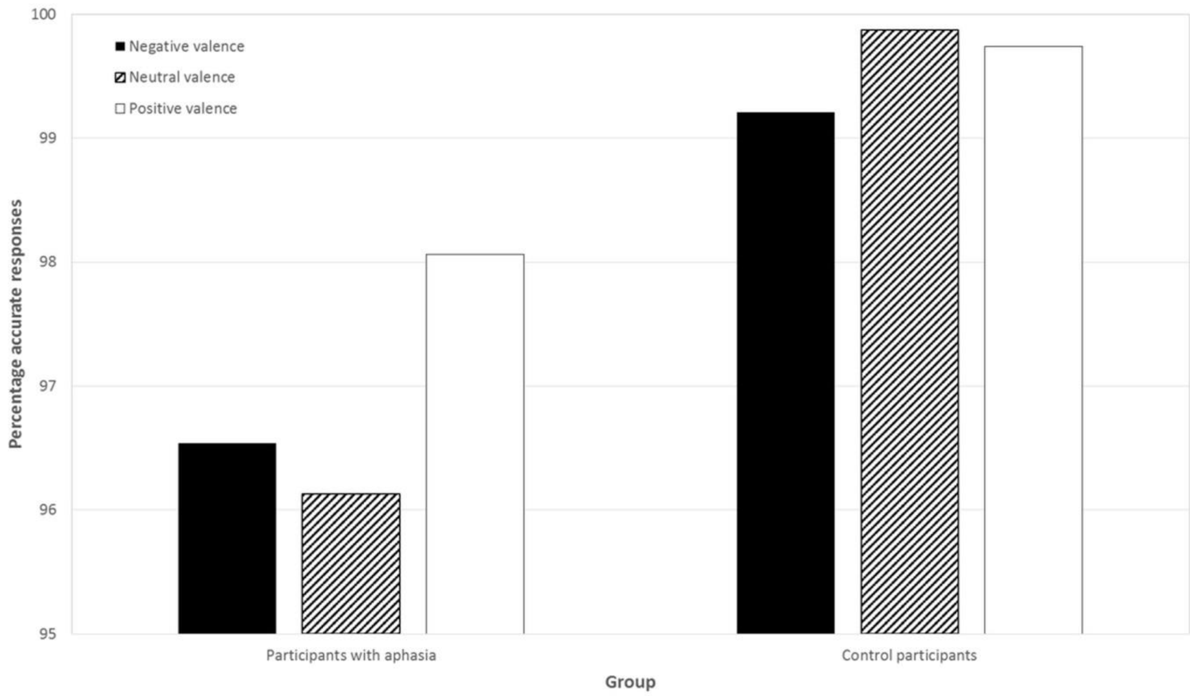


Figure 1. Accuracy of performance for participants with and without aphasia.

# Measurement of speech parameters in casual speech of dementia patients

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## Introduction

Individuals with dementia often experience a decline in their ability to use language. Language problems have been reported in individuals with dementia caused by Alzheimer's disease, Parkinson's disease or degeneration of the fronto-temporal area.

Acoustic properties are relatively easy to measure with software, which promises a cost-effective way to analyze larger discourses. We study the usefulness of acoustic features to distinguish the speech of German-speaking controls and patients with dementia caused by (a) Alzheimer's disease, (b) Parkinson's disease or (c) PPA/FTD. Previous studies have shown that each of these types affects speech parameters such as prosody, voice quality and fluency (Schulz 2002; Ma, Whitehill, and Cheung 2010; Rusz et al. 2016; Kato et al. 2013; Peintner et al. 2008).

Prior work on the characteristics of the speech of individuals with dementia is usually based on samples from clinical tests, such as the Western Aphasia Battery or the Wechsler Logical Memory task. Spontaneous day-to-day speech may be different, because participants may show less of their vocal abilities in casual speech than in specifically designed test scenarios. It is unclear to what extent the previously reported speech characteristics are still detectable in casual conversations by software.

The research question in this study is: how useful for classification are acoustic properties measured in spontaneous speech.

## Methods

### *Participant recruitment and data*

The speech data used in this study was collected during a larger study of processing of verbs and nouns in speakers with different types of dementia, currently performed by one of the co-authors (FJ). Participant recruitment, data elicitation and manual CLAN-annotation were performed in the context of that study. Spontaneous speech fragments were elicited from German controls (n=7) and patients with a clinical diagnosis of a form of dementia: (probable) Alzheimer's disease (AD, n=9), PPA (n=3), bvFTD (n=4), Parkinson's disease (PD, n=6), PD with MCI (n=4), PD with dementia (n=3). In this study, only data on controls and participants diagnosed with PPA, AD or PD are reported.

For each participant, discourses on three different topics (past, present, future) were elicited. Because the ultimate goal of the larger study is to track the long-time decline of the linguistic system in non-controls, the elicitation of the three topics was repeated three times with non-controls, with about 6 months between each elicitation session.

## *Narrative sampling*

The interviewer asked participants in separate sessions to speak of childhood memories (topic: past), of a typical day in the present (topic: present), and of plans that they might have for the next week, month or year (topic: future).

Elicitation was done in the participant's own environment. This affects recording quality: background noises are present in the signal, such as children playing, telephones ringing and papers being shuffled. Segments of the interviewer giving instructions or asking questions were removed, but only if they are of significant length and truly interrupt the flow of the discourse of the participant. This was judged by the researcher (RO). The resulting discourses (μ=6m47s; σ=3m30s) are of sufficient length that minor utterances by the interviewer to move the discourse along (*hmm-hmm*, *oh yeah*, etc.) do not significantly impact the data analysis of the speaker's voice characteristics.

## *Acoustic feature extraction*

Audio recordings were analyzed for voice activity using an unsupervised learning framework (Ying et al. 2011), and for pitch using an automatic pitch extraction algorithm implemented in REAPER[1].

Results of the analyses were stored in a database and then read in by R-scripts for further statistical analysis. Reaper's output (in Hz) was translated to pitch interval (in cents, $P^0$) as proposed by Matteson, Olness, & Caplow (2013).

The following variables were used for analysis:

1. Fluency
    1. Pause length
    2. Pause frequency
2. Phonation
    1. Duration of speech
3. Voice quality
    1. Jitter
    2. Shimmer
4. Prosody
    1. Pitch level
        1. mean, median, maximum and minimum $P^0$
    2. Pitch range
        1. SD
        2. Four standard deviations around the mean (SD4)
        3. Max-min $P^0$
        4. The difference between the 95th and the 5th percentile (HDI, 90% span)
        5. The difference between the 16th and the 84th percentile (HDI 68% span)
        6. Skewness and kurtosis

## *Machine learning*

We trained a generalized linear multilevel model using R and Stan (McElreath, 2016; R Core Team, 2017) and evaluated its performance. Evaluation was conducted using five-fold cross-validation over the set of fragments. In each of the five folds, the parameters of the model were first learned in a

[1] David Talkin, https://github.com/google/REAPER.

training phase using 80% of the data, and then applied to the held-out data to predict the participant's diagnosis. This procedure is repeated for each of the five folds, with accuracy being the average performance on the test data across all folds.

# Results

Results are compared to a baseline ("Zero Rule") strategy that always predicts the majority class. The classifier is considered informative if it performs better than the baseline strategy. Machine learning results suggest that the proposed model is superior to the baseline standard of predicting the majority class, measured as the area under curve (AUROC), cf. figure 1. Individual univariate Wilcoxon rank sum tests, adapted with Benjamini-Hochberg correction for false discovery rate (Benjamini and Hochberg 1995), show that SD patients have significantly shorter pauses than controls, and PD patients have significantly lower values for voice quality parameters than controls.

# Discussion

Post-hoc analyses show that most influence in the model comes from fluency and voice quality variables, while prosody variables contribute the least. Monopitch has frequently been associated with dementia speech, but the role of pitch is very limited in the model for this convenience sample. A possible explanation is that casual spontaneous speech invites less pitch variation, both in controls and in patients.

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# Figures

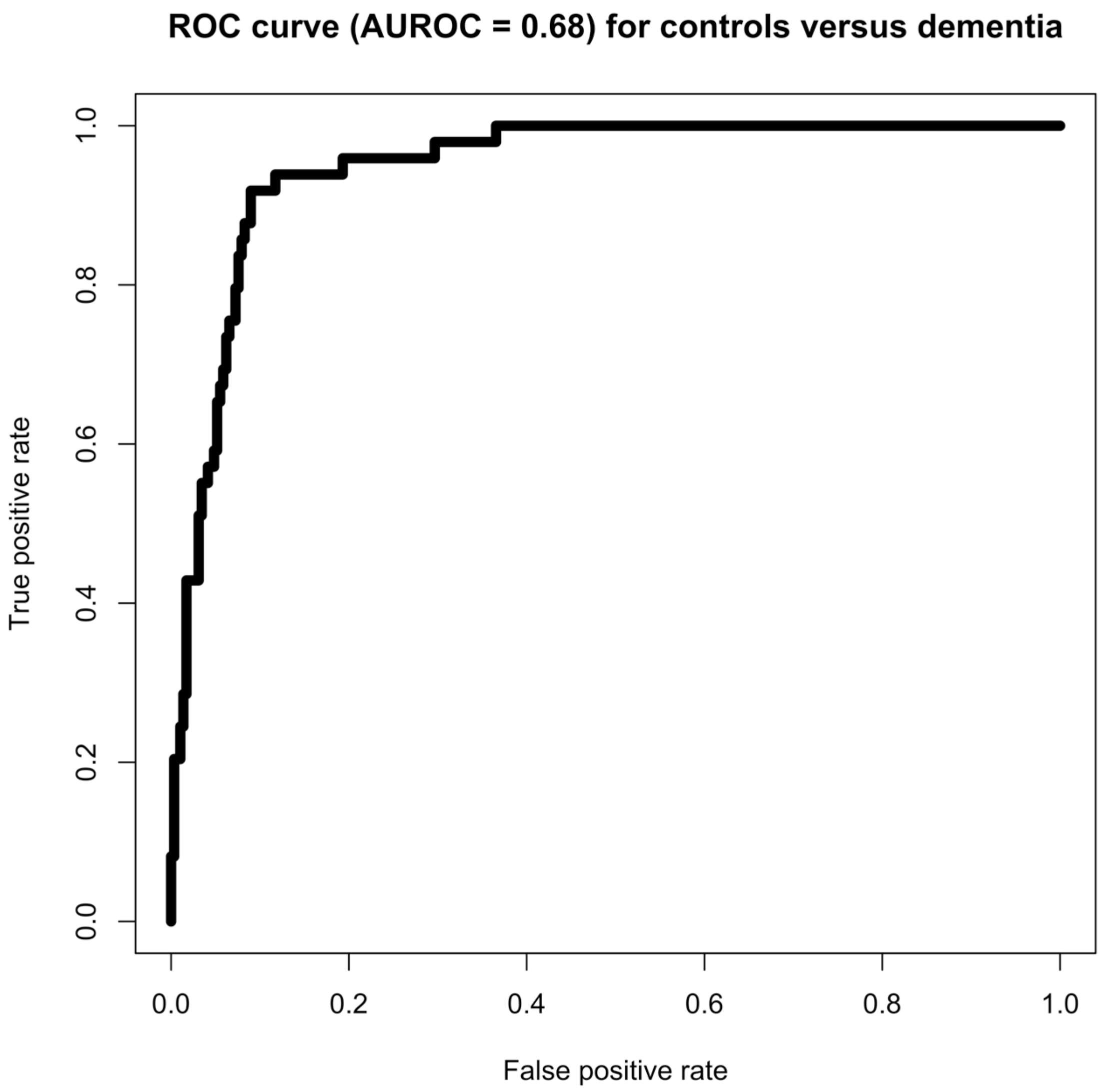


**Figure 1.** Area under Receiver Operating Characteristics for the binary classification of controls versus dementia.

# The Role of Conceptual Number: An ERP Study on Pronoun Processing in Brazilian Portuguese

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## Introduction

Number is a nominal feature that denotes the numerosity of the entity in question. For example, a singular noun such as *car* refers to a single entity, whereas the plural form of the same noun (*cars*) indicates multiple entities (Schweppe, 2013). In general, number is denoted by inflectional morphology (e.g., in English *ø -/ is* used for singular and *-s* for plural nouns), thus being a grammatical/morphosyntactic feature. However, in case of collective nouns (e.g., *orchestra*), number can be deduced from semantics (semantic/conceptual number). Collective nouns are morphologically singular, but they encompass a semantic/conceptual idea of a group of individuals or things.

In the example, "*The gang robbed the bank. They took a lot of money",* the pronoun *they* violates (grammatical) number agreement, by not making a direct syntactic reference to its antecedent, *the gang*, present in the previous sentence. Still, the sentence containing the plural pronoun is grammatical. The anaphoric relationship between the antecedent and the pronoun *they* is conceptual, since the noun phrase (NP) *the gang* refers to a group of individuals. Therefore, for the processing of this sentence to be possible conceptual number has to be used– a *gang* is generally formed by a group of criminals – in order to establish the relationship between the antecedent and its anaphor.

In relation to conceptual number agreement processing in aphasia, Hartsuiker, Kolk & Huinck (1999) investigated conceptual subject-number agreement in agrammatic production. Two sentential fragments completion tasks and one sentence/picture matching task were used, in which conceptual and grammatical number were manipulated. In all tests, Broca´s aphasic speakers did not show sensitivity to number mismatch between conceptual and grammatical information. The authors argued that individuals with agrammatism, when compared to healthy controls, do not have enough computational resources to process both grammatical and conceptual information in morphosyntactic processing and rely more on grammatical information only.

The processing of conceptual anaphors in aphasia has not yet been investigated in detail. However, studies conducted with healthy controls in different languages have shown conflicting data regarding the ease or difficulty of processing sentences containing conceptual anaphors. The studies conducted by Gernsbacher (1991), and Carreiras & Gernsbacher (1992) have shown that conceptual anaphors in English and Spanish were considered more natural than grammatical anaphors. In German, however, the pronoun interpretation relied on the distance between the antecedent and its anaphor (Schweppe, 2013). In Brazilian Portuguese, Farias & Ferrari-Neto (2012), concluded from the results of a self-paced reading task that , even though a significant effect was observed on the verb following the critical item, it took longer for participants to read sentences containing conceptual anaphors (conceptual number) than sentences containing grammatical anaphors (grammatical number).

One possibility of investigating conceptual number agreement is by using a real-time experimental method that could shed light on how the processing of these linguistic elements occurs. Event-related potentials (ERPs) are a good choice for investigating this phenomenon since ERPs are differentially sensitive to syntactic and semantic aspects of comprehension.
Even though we aim to understand how conceptual number in relation to antecedent/anaphor agreement takes place in aphasia, it is still unclear how conceptual number agreement influences coreference establishing between a conceptual plural/syntactic singular antecedent and its anaphor by healthy individuals. For this reason, this study aims to a) investigate the role of conceptual number in establishing co-reference; b) verify which processes and which ERP components are elicited when conceptual number is processed in relation to these different types of anaphors (grammatical versus conceptual).
This study will investigate conceptual number processing in Brazilian Portuguese because the use of pronouns is obligatory in this language, unlike in European Portuguese and Spanish.

# Methods

## *Participants*

Thirty non-brain-damaged native speakers of Brazilian Portuguese, who currently live in the city of Groningen, the Netherlands, will be tested.

## *Materials*

The experiment consists of a passive reading task, which will be presented by using E-prime software and each sentence will be displayed word-by-word. The experimental materials comprise 80 fillers and 240 experimental sentence pairs. In the experimental sentence pairs, the antecedents in half of the introductory sentences will be collective nouns (conceptual plural), and in the other half the antecedents will be nouns with grammatical number (grammatical plural). In the four conditions, the sentence pairs will present two types of introductory sentences when establishing coreference with the sentence that contains the anaphor (personal pronoun):

**Introductory Sentence 1 + Anaphoric sentence:** Noun Phrase (NP – Antecedent) + Intransitive verb + Prepositional Phrase (PP). Pronoun (Anaphor) + transitive verb + object.

**Introductory Sentence 2 + Anaphoric sentence :** Noun Phrase (NP – Antecedent) + Transitive verb + Noun Phrase (in a different gender from the previous NP). Pronoun (Anaphor) + transitive verb + object.

Forty collective nouns will be used, of which twenty masculine and twenty feminine. The experimental conditions are presented as follows:

**Condition 1 – Conceptual plural of the NP – Masculine collective noun:**

*Level 1 (Grammatical number agreement – conceptual number mismatch);*
*Level 2: (Grammatical number disagreement – conceptual number match);*

**Condition 2 – Conceptual plural of the NP – Feminine collective noun:**

*Level 1 (Grammatical number agreement –- conceptual number mismatch);*
*Level 2: (Grammatical number disagreement – conceptual number match);*

**Condition 3 – Grammatical plural of the NP – Masculine Noun:**

*Level 1 (Grammatical number disagreement –- conceptual number mismatch);*
*Level 2: (Grammatical number agreement –- conceptual number match);*

**Condition 4 – Grammatical plural of the NP – Feminine Noun:**

*Level 1: (Grammatical number disagreement –- conceptual number mismatch);*
*Level 2: (Grammatical number agreement –- conceptual number match).*

# Predictions & Discussion

We are currently conducting the experiment. Our hypothesis is that conceptual number agreement demands more levels of processing (both grammatical and conceptual) compared to grammatical number processing (only grammatical information), and is thus more complex to process. The increase in processing is expected to be reflected in a larger P600 effect. We predict that sentences containing a conceptual number violation (collective noun – singular + personal pronoun – singular) will elicit a larger P600 effect, when compared to sentences that present a grammatical number violation (collective noun – singular + personal pronoun – plural).

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# Comparing EMG and voice key responses as indicators for speech onset time in EEG research on speech production

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## Introduction

The aim of our study is to identify the impaired process of speech production underlying apraxia of speech (AoS). AoS is a neurogenic speech motor disorder, which is usually accompanied with aphasia, a neurogenic language disorder. Some symptoms in the speech of individuals with AoS can occur in the speech of individuals with aphasia or dysarthria, a neuromuscular impairment affecting articulation. This makes a speech-based diagnosis complicated. We are testing whether electrophysiological methods, such as electroencephalography (EEG) and electromyography (EMG) (see below), can be used to identify the underlying disorder of AoS by tracking the entire process of speech production from lemma retrieval until articulation. EEG measures the timing of electrical activity from the neurons in the brain through electrodes that are placed on the scalp. Surface EMG measures the timing of muscle activity with electrodes that are placed on the skin over the muscle. The impaired speech production process in AoS is assumed to precede the impaired process in dysarthria. In AoS the impaired process is the translation of phonemes (speech sounds) into a plan or program in which the movements of the articulators are defined, while control over the muscles used for articulation is disturbed in dysarthria (Lowit et al., 2014). The aim of this study is to find out whether these late processes can be studied in the brain with EEG, or whether we need the EMG of the articulatory muscles as well to differentiate AoS from dysarthria.
It is crucial to measure the speech onset time when analyzing late speech production processes by using EEG. Speech onset time could be measured by using a voice key or EMG. The voice key detects speech when the intensity of the sound recorded by a microphone exceeds 50 decibel. Articulation onset is detected with EMG when the electrical difference measured between electrodes placed on the lips exceeds 75 microvolt. The voice key and the EMG detect a different speech onset time for the same response. The research question in the current study is how the different methods of detecting speech onset time affect the results of four EEG experiments, which were conducted to track speech production processes in control speakers.

## Methods

Ten neurologically healthy native speakers of Dutch, two of which were male, participated in four experiments: two picture naming tasks, a pseudoword reading task and a pseudoword repetition task. The items of the first picture naming task were designed to track lemma retrieval through the manipulation of the semantic relationship between successive words (Costa et al., 2009). The second naming task with items manipulated for age of acquisition was designed to track phonological encoding (Laganaro & Perret, 2010). The pseudowords that were used in the reading and repetition tasks were manipulated for syllable frequency to track phonetic encoding (Buerki et al., 2015). We recorded EEG data with 64 channels and surface EMG with two channels on the lips, response times with a voice key and oral responses during the experiments.

### *Analyses*

The EEG data collected during the four experiments have been analyzed twice. In the first analysis the voice key was used to determine the speech onset time. The speech onset time was detected with EMG in the second analysis. We performed an analysis on the last second of EEG data before the speech onset time. This time window contained 512 sampling points. At every sampling point and for each of the 64 channels t-tests were computed to compare the levels of the conditions, which differed per experiment. In naming task one, the naming of the first and the fifth successive item of the same semantic category was compared. Items with early and late age of acquisition were compared in naming task two. In the pseudoword reading and repetition tasks, items with high and low syllable frequency were compared. When a significant difference between the levels of a condition was present in three or more neighboring channels and lasted for at least 30 milliseconds it was reported as an effect. For every experiment, the timing of the last effect before the speech onset time was compared between the two analyses in which the speech onset time was detected through a voice key or through EMG.

# Results and discussion

The results show that the use of different speech onset time detection methods indeed affected the results of our EEG experiments on speech production processes. When the speech onset time was detected by EMG, effects were measured closer to the response onset time than when the speech onset time was detected by the voice key. This was the case for every experiment and thus for every speech production process we tracked. This could be explained by the presence of articulatory muscle activity, which introduced noise to the EEG signal. The voice key detected speech sounds, which often exceeded their threshold after the muscles started moving for articulation. Therefore, the last 100 milliseconds of the EEG data were unusable. The EMG detected the onset of muscle activity, so the EEG signal was analyzed until the threshold of the EMG was reached.
When the voice key was used to detect the speech onset time, effects were generally found earlier during the second of EEG data we analyzed compared to when EMG was used to detect the speech onset time. This shows the importance of combining the methods for the detection of speech onset time. The voice key needs to be used for earlier effects and EMG is necessary for later effects in EEG experiments on speech production. We will apply this knowledge to track speech production processes in individuals with apraxia of speech, aphasia and dysarthria.

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# DTLA – A New Detection Test for Language Impairment in Adults and the Aged

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## Introduction

Aging is the most important risk factor for cognitive decline, and the detection of cognitive impairment in at-risk middle-aged and elderly individuals has become a societal priority. Compared to cognitive functions such as working memory and executive functions, language appeared to be mostly resistant to age-related decline. However, language is affected in the early stages of major forms of dementia and language deficits are at the core of the clinical portrait of primary progressive aphasia [1]. Primary care providers are frequently faced with patients whose main complaints concern language problems in everyday and professional life. To date, there is no brief screening test that could be used during routine office visits to accurately assess language disorders in neurodegenerative diseases. To fill this gap, we developed the Detection Test for Language impairments in Adults and the Aged (DTLA), a quick, sensitive, standardized screening test designed to assess language disorders in adults and the aged [2].

## Methods

### *Development of the DTLA*

The DTLA was developed in four French-speaking countries (Belgium, Canada (Québec), France and Switzerland). The test comprises nine sensitive, easy-to-administer tasks designed to quickly assess the language domains and abilities most frequently affected in neurodegenerative diseases, with particular attention paid to those with the best discrimination value among clinical syndromes. The following tasks were selected: 1) picture naming; 2) word, non-word, and sentence repetition; 3) verbal fluency; (4) spelling to dictation of words and non-words; 5) spontaneous written sentence production; 6) reading aloud of words and non-words; 7) sentence-to-picture matching; 8) written word matching; 9) Alpha-span. For each of them, the number of items as well as their psycholinguistic characteristics were determined with the objective of developing a short test, which could be administrated in approximately 5 minutes.

A pilot study with four times as many stimuli as required for the final version of the test was administrated to 106 healthy participants (mean age= 65.2 years, SD= 9.5) in the four French-speaking countries in order to proceed to the final selection of stimuli. The items finally kept were those for which the best scores were obtained in the four countries (from 87% to 100% of correct). The scoring method was established according to the relative value of each subtest for the detection of language impairment for a total maximum score of 100 points.

### *Study 1: Validity and Reliability of the DTLA*

Convergent and discriminant validity of the DTLA as well as its test-retest reliability and internal consistency were established by including participants presenting with neurodegenerative diseases and participants with post-stroke aphasia. Convergent validity was established with a sample of 31 patients who were asked to complete the DTLA and a series of other tests measuring the same constructs. Discriminant validity was tested by comparing the performance of 24 patients (12 AD patients and 12 post-stroke aphasic patients) matched to 24 healthy control participants by age and education on the DTLA score. Test-retest reliability was established by administrating the DTLA twice to 20 healthy participants with a 6-month interval. Consistence interne was studied with a sample of 602 participants divided into 4 groups (561 healthy participants, 20 patients with Alzheimer's disease (AD); 17 patients with post-stroke aphasia; and 4 patients with primary progressive aphasia).

### *Study 2: Normative data for the DTLA*

545 healthy, community-dwelling, French-speaking adults were recruited in the four French-speaking countries (Belgium, n=76; Québec, Canada, n= 99; France, n= 255; Switzerland, n= 115). All participants had normal age- and education-adjusted MMSE scores (≥ 26), indicating normal cognition. Participants were recruited to form four mutually exclusive age and education groups (Table 1).

## Results

Study 1: The DTLA has good convergent validity: The external measures correlated significantly and positively with the corresponding DTLA subtests, except for the digit span that failed to show a significant correlation with the alpha-span. Discriminant validity is good: The DTLA clearly distinguishes between the performance of controls and AD patients (p<.001) and controls and aphasic patients (p<.001). The reliability of the DTLA is also satisfactory, showing a good stability over time (test-retest reliability, indicating no difference between the first and second testing), as is its internal consistency (Cronbach's alpha coefficient of .84).

Study 2: The 5$^{th}$, 15$^{th}$, 25$^{th}$ and 50$^{th}$ percentiles for the DTLA score were calculated for each group. After visual exploration of the whisker plots and according to the usual criteria [3], the 5$^{th}$ percentile was chosen as the most reliable cutoff score. An alert score (15$^{th}$ percentile) was also proposed (table 1).

Table 1: Descriptive statistics of the four groups of participants for the normative study

| | Age | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ≤ 65 years | | | | 65 + years | | | |
| | Education | | | | Education | | | |
| | ≤ 11 years | | 12+ years | | ≤ 11 years | | 12+ years | |
| | Mean | SD | Mean | SD | Mean | SD | Mean | SD |
| Age (years) | 57.45 | 4.42 | 55.93 | 3.95 | 71.74 | 4.73 | 70.45 | 4.83 |
| Education (years) | 9.86 | 1.77 | 14.81 | 2.42 | 9.40 | 1.43 | 15.04 | 2.47 |
| % Women | 59 | | 54 | | 63 | | 53 | |
| N | 126 | | 166 | | 124 | | 129 | |
| DTLA (/100) | 93.88 | 6.99 | 97.73 | 4.19 | 91.58 | 8.23 | 96.35 | 5.88 |
| Alert zone (15th perc.) | 84 | | 94 | | 83 | | 92 | |
| Cutoff (5th perc.) | 78 | | 85 | | 75 | | 81 | |
| Total N | 545 | | | | | | | |

## Discussion

This study provides psychometric and normative data for the DTLA, a new screening test for the quick assessment of language abilities in adults and elderly people. The suggested cutoff and alert scores should be used respectively to confirm the presence of a language impairment or to raise a flag and prompt further extensive language assessment.

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# Dealing with constraints: Analysis of a visual language devised by a man with fluent aphasia

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## Introduction

Blissymbolics (Bliss, 1949) is a visual language first designed to strengthen intercultural dialogue, but mostly applied as a mean of compensation for people with communication impairment. Inspired by Chinese characters, the language is to a large degree pictorial, reducing arbitrariness in the relationship between symbol and meaning. The grammar of Blissymbolics is parasitic to English; it is a word-order based SVO language in which each basic feature of English grammar has an equivalent. People with moderate to severe aphasia have been able to learn symbols, but training of the grammar has not been successful (Funnell & Allport, 1989; Johannsen-Horbach, Cegla, Mager, Schempp, & Wallesch, 1985; Sawyer-Woods, 1987).

We report a modification of Blissymbolics devised by Dr Anthony O'Donnell, an English native speaker (O'Donnell wished to be identified with this work and has been in the past). O'Donnell had a stroke which damaged posterior temporal and parietal areas, causing severe aphasia and a right homonymous heminopia. He sought alternatives to the languages he had mastered, but now could not understand or produce without many errors. He discovered Blissymbolics and over the time developed his own dialect (O'Donnell, Bruce, Black, & Clayton, 2010). The dialect deviates substantially from both his native language English and original Blissymbolics.

This project aims to describe the properties of the dialect and explores how they may be considered a compensation for O'Donnell's particular impairment.

## Methods

We tested O'Donnell on a range of standardized assessments of word comprehension and production (Comprehensive Aphasia Battery; Boston Naming Test), sentence comprehension (Test of Reception of Grammar), verbal working memory (PALPA13), non-verbal reasoning (WASI-II Matrix Reasoning; Raven's Coloured Progressive Matrices), non-verbal executive function (Brixton Spatial Anticipation Test) and non-verbal semantics (Pyramids and Palm Trees picture version). We elicited spoken English through semi-structured interviews and picture description tasks.

In our analysis of the dialect we focused on grammatical features. Our analysis was structured according to the World Atlas of Language Structures (WALS; Dryer & Haspelmath, 2013). We analyzed samples which O'Donnell produced over many years, and over four sessions aimed to elicit further materials in order to satisfy WALS grammatical features.

## Results

O'Donnell's English contained many grammatical (in particular morphological) errors and paraphasias. Standardized assessments demonstrate that he had severe word production and sentence comprehension impairment, moderate impairment of verbal working memory and mild word comprehension impairment with an advantage for written language. In particular, O'Donnell had difficulties with non-canonical sentences and extrapositions. O'Donnell's performance in non-verbal tests ranged from low average (Brixton) to above average (matrix reasoning).

Compared to English and traditional Blissymbolics, O'Donnell's dialect shows a general reduction of morphology which coincides with omissions of several construction types. For instance, we did not find any auxiliary verbs for marking tense. We could also not elicit perfect or progressive aspects. Further, the dialect contains no passive voice and no copula.

Word order is generally less restrained. O'Donnell transformed the ”action marker” in Blissymbolics into a subject marker, which resulted in a more free word order. In our sample we have found SVO, VSO, SOV and OSV word orders, with the first two appearing to be dominant. Obliques precede the verb, with the dominant word order XVO. In ditransitives the dialect appears constrained to verb-subject-directObject-indirectObject.

# Discussion

There are possible links between O'Donnell's impairment and features of his dialect. The pictorial nature of the symbols may have compensated for his lexical-semantic impairment. Reduction of morphology (compared to English and Blissymbolics) may make the dialect easier to parse for someone with impaired verbal working memory. It also results in shorter visual strings which may be easier to parse for an individual with heminopia.The general loosening of word order comes with the very small morphological "cost" of introducing a subject marker and this may help individuals who have an impairment of word-order processing. While we have no conclusive evidence for such impairment in O'Donnell, it has been reported that aphasic individuals had difficulties with word order in Blissymbolics (Funnell & Allport, 1989).

O'Donnell's approach differs from other compensatory interventions in that he did not accept a "prescribed" language system, but tailored one to suit his language profile. We are currently looking for opportunities to reproduce this effort with other individuals with aphasia.

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# "A great deal" versus "a fair deal": Does collocation strength determine processing speed in aphasia?

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## Introduction

Aphasic language processing is known to be affected by lexical variables such as age-of-acquisition, frequency and length (e.g., Nickels & Howard, 1995). Investigations based on everyday conversational data demonstrate that speakers with non-fluent aphasia make use of common, high-frequency word combinations (i.e. collocations like "*I suppose*", "*wait a minute*" or "*I know*"; Beeke, 2003; Heilemann, Varley, Zimmerer, Carragher, & Beeke, 2016). This indicates that frequency or familiarity might exert an influence beyond the single word level.
A number of psycholinguistic studies reveal a processing advantage for common, high frequency phrases (e.g., *at the moment*) over matched, less common phrases (e.g., *at the church*) in neurotypical speakers (Arnon & Snider, 2010; Jiang & Nekrasova, 2007; Tremblay, Derwing, Libben, & Westbury, 2011). However, experimental evidence for such phrase frequency or collocation effects in aphasia is relatively rare (e.g., Lum & Ellis, 1999). The present study investigates whether participants with aphasia (PWA) and neurotypical controls show sensitivity to collocation strength in an on-line processing task. We aim to provide insight into the size of units stored within the mental lexicon and explore aphasic language processing from a usage-based perspective.

## Methods

### *Participants*

Data from 45 neurotypical control participants (N = 22 in a younger control group, average age = 20.6 years, SD = 3.1; N = 23 in an older control group, average age = 62.7 years, SD = 10.4) and a group of PWA were collected. All participants reported English as their main language.

### *Materials and procedure*

We employ a word monitoring task (WMT), in which the participant reacts (via button press) to a pre-specified target word as quickly as possible once it is encountered in a sentential context (Tyler, Moss, Patterson, & Hodges, 1997). The WMT is an implicit task that reveals, via reaction times (RTs), whether participants are sensitive to targets that appear in varying sentential contexts. Our stimuli consist of pairs of three-word combinations (trigrams). The final word of each trigram pair serves as the target (nouns such as *PEOPLE*) and is either part of a stronger collocation (e.g., *all the PEOPLE*) or a weaker collocation (e.g., *all three PEOPLE*). All trigrams are derived from the spoken subcorpus of the British National Corpus (BNC, 2007). We use t-scores, a frequency-related measure of the degree of association between the units of an n-gram (in this case a trigram), in order to determine collocation strength. Higher t-scores indicate greater collocation strength (e.g., $t_{all\ the\ PEOPLE}$ = 10, versus $t_{all\ three\ PEOPLE}$ = 2). All trigrams are embedded in longer, grammatically well-formed sentences which are presented auditorily.

Our WMT comprises three conditions: first-word manipulations (18 pairs, e.g., ***round** the CORNER* vs. ***near** the CORNER*), second-word manipulations (18 pairs, e.g., *a **long** TIME* vs. *a **nice** TIME*) and common versus less common noun pairings (CNPs; 12 pairs, e.g., ***cats** and DOGS* vs. ***birds** and DOGS*). CNPs were originally included as distractor items as they are more salient than the trigrams in first- and second-word manipulations. The dependent variable is normalized RT difference (z-score difference) per trigram pair, where a positive z-score difference indicates facilitation of the stronger as compared to the weaker collocation.
In addition to the WMT, participants in the aphasic and the older control group are assessed with a number of cognitive and language tests including a cloze task devised for the purposes of the current study.

# Results

Facilitation of word recognition in stronger collocational constructions was found in all conditions in both younger and older neurotypical control participants. Moreover, there was a positive relationship between collocation strength and degree of facilitation in the younger control group, whereas older adults do not show this sensitivity. Preliminary results of seven PWA indicate a shift from normative patterns in that facilitation was found in second-word manipulations and CNPs, but not in first-word manipulations.

# Discussion

The current study investigates recognition of words which are embedded in stronger and weaker collocations, derived from naturalistic speech. Facilitation across conditions in neurotypical controls provides evidence for a processing speed advantage of stronger collocations. Collocation strength, as measured by t-scores, determines the degree of facilitation in younger, but not in older controls. This suggests that with more linguistic experience, a threshold (stronger vs weaker) rather than a degree of collocation strength might be in place. In PWA, preliminary evidence indicates facilitated processing in stronger as compared to weaker collocations when the critical word immediately precedes the target, or when the target is primed by a noun (CNPs). However, facilitation in CNPs might reflect a semantic priming effect rather than an effect of collocation. Relationships between sensitivity to collocation strength and other cognitive and language variables will be reported. Questions about underlying cognitive mechanisms (e.g., whether collocations are stored as chunks in 'lexical' memory, or whether the first word(s) of a collocation prime the rest of it; whether distance or word class govern strength of facilitation) need to be further explored.

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# Automatically distinguishing Mild Cognitive Impairment, Alzheimer's Disease and education effect in healthy aging in narratives in Brazilian Portuguese

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## Introduction

Language assessment is an important complementary tool for diagnosing the onset and progression of neurocognitive diseases, such as Alzheimer’s Disease (AD) and Mild Cognitive Impairment (MCI). Narrative production and comprehension are necessary for functional integration in daily activities and can serve to verify subtle or prominent changes in processing. However, due to the complexity of texts analyses, they have often been neglected in clinical evaluation, with word and sentence level assessment being a more common tool for diagnosis. Two factors that affect language processing, and should be considered in language assessment are educational level (normally correlated to socioeconomic status) and reading and writing habits. In underdeveloped countries, low educational level may compromise the diagnosis of cognitive impairment, since scores for this population may be lower in cognitive and neuropsychological tasks as a consequence of low schooling (Ardila et al., 2010; Chaves, Izquierdo, 2009).

There is a lack of batteries and tasks suited to assess cognitive changes in healthy aging and decline in neurodegenerative diseases in low educational level. BALE – Bateria de Avaliação da Linguagem no Envelhecimento (Hübner et al, in preparation) has been designed to assess semantic and discourse abilities in distinct educational levels in healthy aging and in neurodegenerative diseases.
Automated discourse analysis tools have been applied to narrative transcripts in Brazilian Portuguese (Aluísio et al., 2016; Cunha et al., 2015). However, the absence of sentence boundary segmentation in transcripts prevents the direct application of methods that rely on these marks for the correct use of tools, such as taggers and parsers. To our knowledge, only one study evaluating automatic sentence segmentation in English transcripts of aphasic elderly people exists (Fraser et al., 2015).
In this presentation, results from two discursive subtasks of BALE will be presented, one consisting of the retelling of an orally presented narrative, and the other a narrative production based on a sequence of scenes. Data analyses are performed by DeepBond, a method of automatic sentence

segmentation (Treviso et al, 2017), together with the use of Coh-Metrix Dementia (CMD) (Aluísio et al, 2016; Cunha et al., 2015), which provides 73 metrics, including syntactic complexity.
Moreover, data from questions measuring micro and macrostructure comprehension and text propositions are analyzed.

# Methods

## *Participants*

101 healthy participants took part in the study (divided into high (HE), low (LE) and very low education (VLE)), with 19 AD and 17 MCI divided into low and very low education. The HE participants had a mean age of 68.1 (±5.2) and >8 years of formal education (n=53); LE had a mean age of 71,0 (±6.3) and 4-8 years of education (n= 34); VLE had a mean age of 72.1 (±6.3) and 0-3 years of education (n= 14). Low education MCI participants had a mean age of 72.4 (±4.0) (n=9) and the very low education group mean age was 70.6 (±5.9) (n=8); low education AD participants had a mean age of 73.5 (±6.3) (n=10), and the very low education group a mean age of 72.0 (±10.0) (n=9). Exclusion criteria for all participants were uncorrected vision or auditory problems, vascular cerebral diseases, tumors, untreated diabetes or depression, psychiatric diseases, drug or alcohol addiction. AD participants with CDR ≥3 were excluded.

## *Instruments*

**a) For organization of groups**

**- administered to all groups:** depression scale GDS (Yesavage et al., 1982), MMSE (Folstein et al., 1975), Pfeffer Questionnaire (Pfeffer et al, 1982), Edinburgh Handedness Inventory (Oldfield, 1971), Questionnaire of general health (Fonseca et al., 2007), Questionnaire of Reading and Writing Habits and Frequency (Pawlowski et al, 2012)
**- administered to MCI and AD diagnoses:** the criteria recommended by the National Institute on Aging-Alzheimer's Association (Mckhann et al., 2011), Clinical Dementia Rating (Berg, 1988), MINI PLUS (Amorim, 2000) – version 5, complemented by the criteria of the Diagnostic and Statistical Manual of Mental Disorders – DSM-IV-TR,)

**b) For linguistic assessment (narratives)**

Two subtests of BALE were adopted:
- oral story retelling of a short narrative orally presented (*Lucia's Story*)
- oral story telling following the presentation of a narrative composed of seven scenes, presented in the correct sequence (*The dog story* (Le Boeuf, 1976))

c) **For neuropsychological assessment** (not explored in this presentation)

- Digit Span (Weschler, 1997)
- Verbal fluency (phonological and category) (Fonseca et al., 2008)
- Clock drawing (Sunderland et al., 1989)

# Results

Preliminary results showed statistical differences between low and high education healthy aged participants. Statistical differences were also observed when comparing healthy aged and MCI participants, both groups with low educational level. Analyses are under development in order to refine the differences and similarities between AD and MCI groups.

# Discussion

Results suggest that the pipeline of tools, composed of DeepBond and Coh-Metrix-Dementia, is robust enough to analyse impaired speech and can be used in automated discourse analysis tools to differentiate narratives produced by low education clinical populations and healthy controls, and for comparing the narrative production of healthy participants with low and high educational level. Thus, narrative production seems to be an effective complementary tool for distinguishing MCI and AD clinical groups and groups of high and low educational level.

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# Mismatch negativity and category specificity in Hungarian - an EEG study

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## Introduction, theoretical background

Lexical semantics can be seen as a relation between symbols and what they represent, or as a relationship to other symbols and their meanings (Hauk, 2016;777). It is well known that depending on the salience of a word of a natural language it could be a very complicated process to classify a concrete word as an element to a specific category ( Rosch, 2009).

Balass – Halderman – Benau and Perfetti (2016) assumed in their previous study „that semantic category decisions (i.e., is a canary a type of bird? versus is a feather a type of bird?) facilitate the conditions for a cognitive conflict when foils (feather) share semantic features with category members (canary). When the meaning of a target word is activated, other associated meanings related to that word are activated as well. The additional activation of associated meanings may create a conflict at the time of the response. This conflict in semantic processing should be reflected in the ERN, according to the predictions made by the conflict-monitoring hypothesis of the ERN." Their main assumption of their hypothesis was that the ERN reflects the presence of a response conflict. We supposed on the basis of their study that this conflict can be seen as a universal human cognitive response.

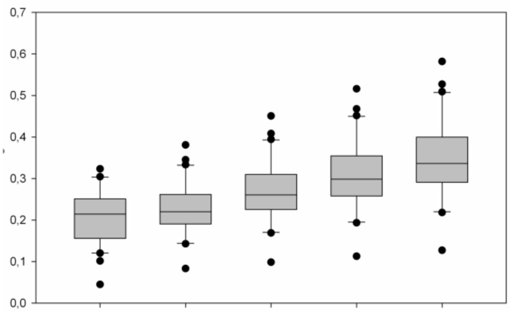
## Participants and Method

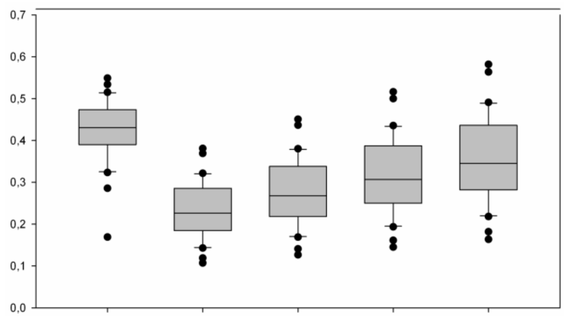
Our experiment with electro-encephalography was delivered at the Biophysical Laboratory of the Department of Physiology at the University of Szeged. It took 45 minutes to participate at the experiment at the laboratory. Each of the participants were tested by linguistic test batteries to explore their mental lexicon and their vocabulary.

Following the original study of Balass et al. (2016) thirty one adult participants completed a time-pressured semantic categorization task to elicit errors to simple semantic category decisions. (N=31 university students, at theage of 21-23,all of them were Hungarian native speakers). The task has been adapted to Hungarian language. We not only translated the items of the original paper, but we created four subgroups of the non-member category depending on the prototypicality and the salience of the different semantic features of the different items. The average number of category members per semantic category was 7.

## Results

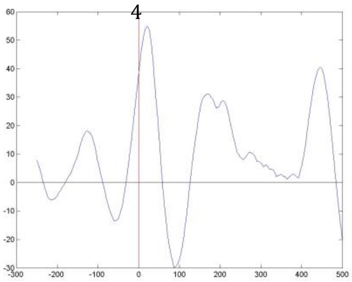
There were significant differences between the wrong answers for related and non-related non-member items of the different categories. There were also significant differences between the wrong answers for correct members of categories.



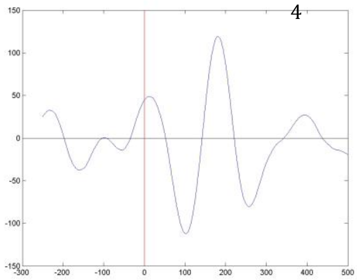


wrong answers
member vs. non-members type 1-4

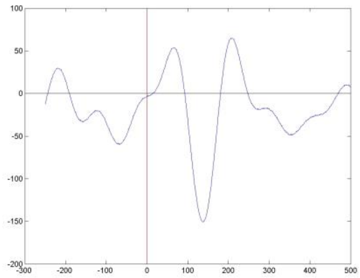
correct answers
member vs. non-members type 1-4



mismatch negativity of wrong answers



mismatch negativity and positivity of correct answers



mismatch negativity of missing answers (time pressure)

Figure 1

# Discussion

The results of the psychophysical part can be seen in the boxplots, according to categories. Each part of the diagram shows what percentage the participants judged to be in the given category of the maximum possible number of elements that were part of the category.

The analysis of the Event Related Potentials yielded the following result: While the original study (in which the participants were native English speakers) found some event related negativity after wrong answers, hitherto our results can not entirely confirm the same findings in a population of native Hungarian speakers. Mismatch negativity was found in some individual cases, however it is not presented in the whole population. On the other hand at 100 ms latency positive wave can be seen after good answers in half of the participants.

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# Language awareness and aphasia assessment: differentiating profiles through the performance of metalinguistic tasks

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## Introduction

The use of language in natural communicative settings and for other self-regulatory functions of human behaviour (some of which are associated to inner speech practices) usually requires the involvement of a procedural awareness of the linguistic tool. Language itself needs to acquire the condition of a perceived object (Werner & Kaplan, 1978; Sigel, 2002), i.e. of an object that needs to be a focus of attention for the development of all its functionalities. Moreover, the projection of attentional capacities on the linguistic tool is a factor required for the normal language development (Gombert, 1992). Language impairment after stroke manifests as a deficit in the techniques for language production and / or comprehension (and for writing and / or reading), but also as a deficit referring to the capacity of sustaining attention to language and monitoring language use for different functions. This aspect of the linguistic impairment in people with aphasia has been object of interest in recent literature, where the classical symptom of anosognosia has been reformulated in terms of a more general deficit on the projection of executive functioning capacities in the management of verbal behaviour (Penn, Frankel, Watermeyer, & Rusell, 2010; El Hachoui *et al.*, 2014; Mayer, Mitchinson, & Murray, 2016, Dean, Della Sala, Beschin, & Cocchini, 2016). Examining natural metalinguistic abilities, as a way of testing the reflectivity and attentional capacity on language, has proved to be useful in establishing differential characterizations of aphasic syndromes (Hernández-Sacristán, Rosell-Clari, Serra-Alegre, Quiles-Climent, 2012).

## Methods

### Assessment tool

In order to assess reflectivity and attentional capacity on language, we have use the *MetAphAs* test (*Metalanguage in Aphasia Assessment)*. This is a 40-item test assessing abilities such as inner, inhibited, and deferred speech, control of concurrent semiotic procedures, like gesturing, paraphrastic activity ("saying in other words"), reported speech ("referring to words uttered by others"), monitoring language production and reception, as manifested, for example, in self- and hetero-corrections, displaced use of language, particularly when assuming the interlocutor perspective in language production and comprehension (*Theory of Mind*). The tasks included in this test are representative of common monological situations and natural conversational settings, and all of them involve a procedural awareness of language. As a preliminary approach, *MetAphAs* had been proposed by Hernández-Sacristán *et al.* (2012), and then developed further by Rosell-Clari & Hernández Sacristán (2014).

### Subjects

30 aphasic Spanish-speaking subjects participated in the study (19 men and 11 women, with ages ranging from 41 to 82). Participants had suffered a stroke at least 6 months prior to the study and had been given an ischaemic or haemorrhagic diagnosis. They were recruited from the stroke units at hospitals in the cities of Valencia and Alzira (Spain). All subjects completed the Spanish version of the *Boston Diagnostic Aphasia Examination* (*BDAE*) (Goodglass & Kaplan, 1983, 1998). A variety of aphasia types was represented in our sample: 17 people with dominant motor aphasia, 8 with

dominant sensitive aphasia and 5 with residual anomic aphasia. As regards severity, a variety of situations was also represented in our sample, although most of the participants (twelve of them) were moderate cases. Patients with a very severe deficit in speech production or comprehension were excluded from our study, given the difficulties they would likely face in completing the *MetAphAs* test.

### *Procedure*

The *MetAphAs* test was administered to all participants to assess to what extent metalinguistic abilities, as previously defined, were impaired. Data obtained from *BDAE* and *MetAphAs* test were analysed by means of the PASW Statistics 22 software program.

## Results

Internal consistency (reliability) of *MetAphAs*, was proved by the high values of the Cronbach's alpha coefficient, applied to the scores obtained by all patients. Validity (concurrent validity) of *MetAphAs* was also proved by the high values of Pearson's coefficients measuring the correlation between the *BDAE* and the *MetAphAs* global scores. There were, however, significant average differences between the *MetAphAs* and the *BDAE* global scores ($t_{29}$ = -8.712; p = .000), demonstrating that *MetAphAs* and *BDAE* were, as expected, different ways of assessing aphasia. The *MetAphAs* test was high sensitivity to the aphasia type ($F_{(6,71)}$ = 11.689; p = .000) and to the severity of aphasia ($F_{(6,71)}$ = 40.378; p = .000).

**TABLE 1**
**Summary of Results**

| | | |
|---|---|---|
| **Reliability: *MetAphAs* test** | Cronbach's alpha coefficient = .926 | From 0 and 1 |
| **Correlation: *MetAphAs* / *BDAE*** | $r_{xy}$ = .900 | p = .000 |
| **Average differences: *MetAphAs* / *BDAE*** | $t_{29}$ = - 8.712 | p = .000 |
| **Aphasia Type & *MetAphAs*** | $F_{(6.71)}$ = 11.689 | p = .000 |
| **Aphasia Severity & *MetAphAs*** | $F_{(6.71)}$ = 40.378 | p = .000 |

## Discussion

Our results confirm previous findings about the interest in assessing language awareness in people with aphasia in order to differentiate profiles of language impairment derived from stroke and to establish a baseline for language rehabilitation. Impairment in language awareness can be considered a specific subdomain of the concomitant cognitive impairments associated with aphasia referred to by recent literature (Cf. El Hachoui *et al.*, 2014, for a review of contributions). It is a cognitive subdomain in a very close relationship with verbal behaviour or, in fact, a subdomain where executive functioning and verbal behaviour blend together. Assessing language awareness in people with aphasia by means of a battery of natural metalinguistic abilities, as proposed in *MetAphAs*, is sensitive to both severity of aphasia and aphasia type.

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# The assessment of verbal fluency in patients with fluent and nonfluent aphasia [2]

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## Introduction

Assessment of verbal fluency is an important component of neuropsychological evaluation in brain-damaged patients. Verbal fluency depend on many cognitive and language processes, including searching semantic memory, selecting semantic representations, accessing the corresponding phonological representations, motor planning and articulation of selected words. The main goal of this study is to examine phonemic and semantic fluency in patients with different type of aphasia.

## Method

A total of 40 patients (20 with fluent and 20 with nonfluent apahsia), aged 53-73 participated in this study. All patients were right-handed, with a single left hemisphere CVA; they were at least six months post-onset without apraxia of speech, dysarthria and/or dementia. The diagnsois and type of aphasia was done by the adapted version of the Boston Diagnostic Aphasia Examination. According to the aphasia severity rating scale, all patients were divided in two groups: 1. severe aphasia and 2. moderate aphasia. To evaluate phonemic fluency we administered the adapted version of the Controlled Oral Word Association Test which requires patients to generate as many words as they can that began with the letter 'K', then 'M', and "S" for duration of 60 seconds each, while semantic fluency was evaluated by asking patients to orally name as many animals as they could, for duration of 60 seconds.

## Results

The obtained results showed that all examined patients achieved low scores on both verbal fluency tasks. In addition, all patients showed significant higher scores on semantic fluency compared to phonemic fluency. Patients with nonfluent aphasia showed significantly worse performance in phonemic and semantic fluency compared to the patients with fluent aphasia.

## Discussion

Our results suggest that type of aphasia and site of brain lesion have influence on verbal fluency. The patients with nonfluent aphasia and predominantly frontal cortex lesion have more difficulty on verbal fluency tasks than patients with fluent aphasia and temporo-parietal cortex involvement. It

[2] This study was done as part of the project ,,Treatment evaluation of acquired speech and language disorders " (Project No 179068) funded by the Ministry of Education, Science and Technological Development of Republic of Serbia.

pointed out that verbal fluency tasks performance might provide additional insight into cognitive and language dysfunction in aphasia.

**Key words**: *fluent aphasia, phonemic fluency, nonfluent aphasia, semantic fluency*

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# The encoding of numerosity in quantification expressions. Insight from an ERP study.

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## Introduction

In inflectional languages like Italian, morphological Number values marked on nouns encode information about the numerosity of the referents. The value of singular typically denotes a numerosity of one, whereas the value of plural denotes a numerosity different from one. Likewise, quantifiers can also convey referential information about numerosity: when a noun is modified by a quantifier it must accordingly agree with the quantifier in Number.

Italian offers a particular testing ground to contrast the Number value marked on a noun and the Number value encoded by a quantifier, without exploiting a violation paradigm. The quantifiers *qualche* and *alcuni/e* both refer to a plural numerosity, meaning 'some' (i.e. Zamparelli, 2007). Yet, while a noun following *alcuni/e* congruently surfaces in the plural (*NounPL*), a noun following *qualche* surfaces in the singular (*NounSG*). Previous behavioural studies exploiting a picture-phrase matching paradigm reported longer response times for the condition *qualche+NounSG* with respect to the condition *alcuni+NounPL* (Gastaldon et al., 2015; Zanini et al., 2015). The authors traced back such result to an increased cognitive effort needed when the Number value of a noun mismatches with the numerosity encoded by the quantifier or the numerosity represented in the picture.

The present study aims at testing whether such mismatch elicits ERP components traditionally associated with morphosyntactic violations. The goal is to disentangle whether the information of numerosity encoded in the noun by the Number morpheme is accessed even when such noun is embedded in a quantifier phrase.

## Methods

### *Participants and materials*

26 right-handed Italian native speakers participated in the study (mean age = 24.5; SD = 2.98).

30 nouns referring to countable, concrete objects were chosen. All nouns were controlled for frequency of occurrence by means of the it-WaC corpus (Baroni et al., 2009) and orthographic length. The length and the frequency of the whole phrase *qualche/alcuni + Noun* were also controlled.

Two pictures were created for each noun: one representing one object, and one representing the same object repeated four times. Each picture was presented twice: once with *qualche+NounSG* and once with *alcuni+NounPL* (table 1), for a total of four experimental conditions and 120 experimental stimuli. Fillers were added in order to counterbalance each experimental condition (table 1); 120 of them involved a semantic mismatch (e.g., a picture representing four apples was paired with the phrase *qualche/alcune banane* 'some bananas').

Table 1. Experimental (in grey) and filler stimuli.

## *Procedure*

| Condition | Picture | Word 1: quantifier | Word 2: noun | Semantic mismatch | True/False | N° Stimuli |
|---|---|---|---|---|---|---|
| Morphologic | Singular | PL: *alcuni/e* | PL | no | F | 30 |
| | | PL: *qualche* | SG | no | F | 30 |
| | | SG: *un/a* 'a' | SG | no | T | 30 |
| | Plural | PL: *alcuni/e* | PL | no | T | 30 |
| | | PL: *qualche* | SG | no | T | 30 |
| | | SG: *un/a* 'a' | SG | no | F | 30 |
| Semantic | Singular | SG: *un/a* 'a' | SG | no | T | 30 |
| | | SG: *un/a* 'a' | SG | yes | F | 30 |
| | Plural | PL: *alcuni/e* | PL | no | T | 30 |
| | | PL: *alcuni/e* | PL | yes | F | 30 |
| | | PL: *qualche* | SG | no | T | 30 |
| | | PL: *qualche* | SG | yes | F | 30 |

A picture–phrase matching paradigm was developed. The participants were asked to press one key if the phrase matched with the picture (true), another key in the opposite case (false). The presentation of the trials was randomized for each participant. The keys were counterbalanced across the participants.
The structure of each trial was the following: fixation point (1000ms); picture presentation (1000ms); blank (200ms); quantifier (300ms); blank (200ms); noun (300ms); blank of random duration (1000 to 1500ms); screen displaying the response options (until response).
EEG was recorded from 28 active scalp electrodes mounted on an elastic cap. Data were recorded with a BrainProducts amplifier (BrainAmp) with monopolar montage, referenced to the left earlobe. Two additional electrodes were mounted to monitor eye movements. After an initial high-pass filter at 0.5 Hz and removal of bad segments, an Independent Component Analysis (ICA) was performed for the removal of artifacts. Only trials with correct responses were entered in the analysis. ERP Epochs spanned from -200 ms prestimulus to 1500 ms poststimulus. Trial rejection was performed via visual inspection of each trial. Finally average ERPs were low-pass filtered at 40 Hz.
ERPs were analyzed by means of Mass Univariate Statistics approach, (Groppe et al., 2011), by performing a series of pairwise comparisons, corrected with False Discovery Rate method for timepoints and number of electrodes.

# Results

We analyzed ERPs time locked to the presentation of the noun. The mismatch in numerosity between the picture and the final word of the sequence was associated to higher LAN amplitude, spatially distributed mostly on left frontal electrodes. Differently, the mismatch in the semantics elicited a higher N400, with an effect in a similar time windows but mostly on parietal electrodes. No difference was found in the second word between the two target conditions *qualche* and *alcuni/e,* when analyzing the ERP time course after the second stimulus. However, results seem to suggest a higher LAN after the first word in the *qualche+NounSG* condition as compared to *alcuni+NounPL* condition.

# Discussion

In this experiment, a LAN component, traditionally associated with syntactical violation, was elicited in a paradigm not involving grammatical violations but a mismatch between the numerosity of the referents and the numerosity encoded in the language at the morphosyntactic level. This effect was distinguished from an effect related to semantics; in fact a parietal N400 was elicited in conditions involving a semantic incongruence.

We did not find any difference in ERPs time locked to the second word. Namely, after a picture of more than one apple, nouns in the condition *qualche+NounSG* were not associated to a more negative LAN than in the condition *alcuni+NounPL*. However, the quantifier *qualche* seems to be associated to a more negative LAN component than the quantifier *alcuni*/e, bringing evidence for an increased cognitive effort in the case of an underspecified Number value in the quantifier with respect to the referential numerosity. Altogether, these results suggest that the reference to numerosity can be incrementally encoded in language comprehension (Urbach & Kutas, 2010).

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# Dynamic aphasia accompanied by subcortical and insular damage: A single-case study

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## Introduction

Dynamic aphasia is a non-fluent aphasia type characterized by reduced propositional language (Luria, 1966). Impaired inner speech programming and verbal planning were suggested to be the underlying disorders in this aphasia type; motor and sensory aspects of speech processing, lexical access and grammatical encoding are relatively intact in such patients (Akhutina, 2016). Luria (1970) related dynamic aphasia to damage to the left prefrontal cortex (Brodmann's Areas 9, 10, 46). In this study, we present a case of a patient with dynamic aphasia which was not caused by damage to the frontal cortical regions.

## Methods

### *Participant*

The patient is a monolingual Russian-speaking 34-year-old woman who suffered from a single left hemisphere stroke. The assessment took place 35 months after the stroke. The patient was admitted to the Center for Speech Pathology and Neurorehabilitation (Moscow) for a six-week treatment course. According to the neuropsychological investigation administered, the patient had mild dynamic aphasia. No comprehension deficits were reported. We will further focus on behavioral and structural neuroimaging data that were acquired before the treatment, and thus not affected by the intervention.

### *Linguistic assessment*

To measure the severity of aphasia, the patient was assessed with the Token Test via App (Akinina et al., 2015) and interviewed. A 300-word sample was elicited with open-ended questions referring to the present and the past. The interview was audio recorded; the selected sample was orthographically transcribed. The transcription was used to quantify speech rate (words per minute), mean length of utterance (MLU) in words, percentage of correct sentences and sentences with embedded clauses, proportion of finite verbs, numbers of content words, lexical verbs, lexical nouns, semantic paraphasias, phonemic paraphasias, and neologisms.

### *Neuroimaging analysis*

Structural MRI data was acquired using a 1.5T Siemens Avanto scanner. T1, T2-weighted and FLAIR images were realigned, segmented, and coregistered in SPM12 (Friston et al., 1995). A lesion mask was manually delineated in ITK-Snap software (Yushkevich et al., 2006) and then normalized to the MNI152 space in the Clinical toolbox for SPM12 (Rorden et al., 2012). Grey matter damage was quantified by overlaying lesion mask to the Automated Anatomical Labeling template in MRICron (Rorden et al., 2007). The damage to the white matter tracts was analyzed by overlaying the lesion mask over the atlas of white matter pathways obtained from a group of healthy controls (Rojkova et al., BSF 2016). The probability of tract disconnection was quantified in the Tractotron software as part of the BCBtoolkit (Version 4.0; Thiebaut de Schotten et al., 2014).

Table 1. The proportion and probability of disconnection in white matter tracts related to language processing

| Tracts related to language processing | Proportion of tract affected by lesion | Probability of disconnection |
|---|---|---|
| Arcuate, long segment | 0.05 | 0.98 |
| Arcuate, posterior segment | 0.03 | 1.00 |
| Frontal Aslant Tract | 0.03 | 1.00 |
| Inferior Fronto-Occipital Fasciculus | 0.03 | 1.00 |
| Superior Longitudinal Fasciculus III | 0.05 | 1.00 |
| Uncinate | 0.02 | 1.00 |

# Results

The Token Test score of the patient was 30/36, which falls into the normal range (28-36). Overall, the spontaneous speech analysis did not reveal severe linguistic deficits either. However, MLU was noticeably low (3 words), and the percentage of grammatically correct sentences was 47.72%, mainly because of the number of incomplete sentences. Speech production in general was filled with hesitations, which together with low MLU and the large number of incomplete sentences is evidence for a non-fluency, typical for dynamic aphasia. Such performance may also indicate word finding difficulties.

The analysis of the neuroimaging data showed that there was no direct damage to frontal cortical regions, contrary to Luria's (1966) view on dynamic aphasia. Interestingly, the insula was affected (17%) by the lesion. Also, white matter tracts associated with language processing were found damaged (see Table 1). These included the left uncinate fasciculus, the frontal aslant tract, long and posterior segments of the arcuate fasciculus, and the inferior fronto-occipital fasciculus.

# Discussion

This single case demonstrates that dynamic aphasia can emerge not only from damage to the prefrontal cortex. In our patient, the cortical prefrontal regions were not affected by the lesion. However, some of the damaged white matter tracts connect the frontal lobe with the other brain regions (e.g., the frontal aslant tract, the uncinate fasciculus, the long segment of the arcuate fasciculus, and the inferior fronto-occipital fasciculus). Previous studies reported that damage to the aslant tract, the uncinate fasciculus, and the arcuate fasciculus correlate with some spontaneous speech parameters in aphasia (e.g.

fluency, speech rate, efficiency; Marchina et al., 2011; Wang et al., 2013; Basilakos et al., 2014; Hope et al., 2015). The inferior fronto-occipital fasciculus and the uncinate fasciculus are claimed to be involved in semantic processing and lexical retrieval (e.g. Duffau et al., 2014), thus, damage to these tracts probably cause the word finding difficulties. Additionally, it was shown that damage to the insula can also influence language performance in aphasia (e.g., Baldo et al., 2011). Further investigations of the causal role of white matter tracts and insular damage in dynamic aphasia can contribute to the revision of this classical syndrome that was previously claimed to be a result of cortical prefrontal damage.

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# Dual-tasks interference in word planning processes in aphasia depends on the underlying impairment

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## Introduction

Aphasia is commonly defined as an impairment of language processes. However, persons with aphasia usually suffer from impairment in other cognitive functions (e.g. attention, memory, executive functions) (see Villard & Kiran, 2016 for a review). Besides co-occuring with language deficits, impaired attention in aphasia has been shown to possibly cause them to some extent (Hula & McNeil, 2008). This is very likely given that even in healthy speakers, speech production requires some attention (Ferreira & Pashler, 2002). A growing literature uses dual-tasks procedures to test attention requirements in word production but there is still disagreement about which stages require attention and which ones are automatic. A recent study showed that non-verbal auditory distractors in dual-tasks slow down lexical selection whereas verbal auditory distractors impact on lexical and post-lexical processes in healthy speakers (Fargier & Laganaro, 2016). As for aphasic speakers, it has been shown that word production accuracy declined under the most attentional demanding conditions (in focused and divided attention) dual-tasks (Murray, 2000). 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 their underlying impairment. According to the results in healthy participants and assuming that the effects are magnified in brain-damaged participants, we predict that both verbal and non-verbal distractor should impact error rates in aphasic speakers with impaired word retrieval, whereas only verbal concurrent tasks should increase error rates in participants with impaired phonological encoding.

## Methods

### *Population*

12 participants (aged 40- 87, mean 55.7) with aphasia following a focal left hemispheric stroke and 10 control matched subjects (aged 25-69, mean 54.7) with no history of neurological impairment participated in this study. The group of aphasic participants was divided into 2 sub-groups according to the underlying anomic pattern: 6 with impaired word retrieval ("lexical sub-group", producing mainly lexical errors) and 6 with impaired phonological encoding ("phonological sub-group", producing mainly phonological errors) in the single picture-naming task.

### *Material and task*

Participants underwent a 40 items picture-naming task in 3 conditions: single naming task, passive dual-task (auditory distractor to ignore while naming) and active dual-task (one specific auditory stimulus to detect while naming). Auditory distractors were either verbal (5 different syllables) or non-verbal (5 different tones), lasted 280 ms and appeared 300 ms after the onset of the picture.

## Results

Analyses were carried out on picture naming RTs and errors using linear mixed models and generalized linear mixed models for binomial data with participants and items as random-effect factors. In the control group, there was a significant interaction between the condition and the nature of the distractor with increased latencies in dual-task with syllables relative to tones, as well as a main effect of condition with a slowing down in dual-tasks. In aphasic participants, there was a significant interaction between the condition and the profile, as well as a main effect of task condition but no main effect of anomic profile. In the lexical subgroup, there was no main effect of condition nor significant interaction with the nature of the distractor. In the phonological subgroup, there was a significant effect of condition, with decreased accuracy in the active task relative to simple naming independently of the nature of the auditory distractor, as well as a significant interaction between the passive task and the nature of the distractor with better performance in the passive task for tones than for syllables. Analyses carried out on errors confirmed that only phonological errors increased in the active task relative to simple naming.

# Discussion

This study suggests that a concurrent auditory task has different impact on word production in aphasic speakers depending on the underlying impairment, independently of its nature. In particular, only aphasic patients producing phonological errors are sensitive to dual-task interference with auditory distractors presented 300 ms after the picture appears on screen. In line with models of time course of processing stages in word production (Indefrey, 2011; Laganaro et al., 2009; 2011), the timing of the distractors taps into late lexical-phonological processes, which may explain why only the phonological subgroup is affected. The nature (verbal or non-verbal) of the auditory distractor only impacts on the passive listening, which seems to confirm a cross-talk between the nature of auditory distractor and of the word to be produced (Pashler, 1994) only in focused attention, when the auditory distractor has to be ignored. The fact that only phonological errors increased in the active task suggests a post-lexical interference of the concurrent auditory distractor, which only manifests in increased errors when this process is impaired.

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# Speech and gesture production by people with aphasia under varying communicative demands

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## Introduction

People with aphasia (PWA) use various gesture types when they communicate, amongst these are iconic gestures and pantomimes (Sekine, Rose, Foster, Attard, & Lanyon, 2013). Whereas iconic gestures can be used for referring to characters, objects or movement-trajectories, pantomimes can be employed for the imitation of complex motor actions (De Ruiter, 2000; McNeill, 1992). Different gesture types spontaneously produced by PWA were demonstrated to hold the potential to complement or even replace verbal speech in conversations (De Beer et al., accepted; Hogrefe, Ziegler, Wiesmayer, Weidinger, & Goldenberg, 2013). To determine to which extent PWA are able to compensate for their verbal limitations by using gesture, it is crucial to study if PWA can use gestures effectively when communicative demands increase.

In the current study, we therefore examined the influence of varying communicative demands on PWA's usage of different gesture types. We compared gesture use in spontaneous conversation to gesture use in a narration task assuming that the latter task poses higher communicative demands on the speaker, because a) there is less support by the communication partner and b) the participants have much less control over the semantic content.

## Methods

### *Participants*

PWA with different types and severity of aphasia (n = 26) and a control participants who were matched for age and gender (CP) (n = 26) participated in the study.

### *Data collection and analyses*

The production of gesture and speech by PWA and CP were investigated in two different communicative tasks: 1) spontaneous conversation and 2) a cartoon-narration task. Speech and gesture produced by the participants were analysed and gestures were classified into 9 different categories, on the basis of both form and meaning.

## Results

PWA produced fewer words per minutes in the cartoon-narration task compared to spontaneous conversation, whereas the frequency of gestures produced did not decrease in the narration task. Both participant groups produced more iconic gestures and pantomimes in the cartoon-narration task and PWA used those gesture types with a higher frequency than CP.

## Discussion

In PWA, high communicative demands negatively impact the production of speech, but not the use of gestures. Both groups produced more iconic gestures and pantomimes when communicative demands increased. Those effects were more remarkable in PWA than in CP. The results suggest that the properties of the communicative task influence the choice of specific gesture types in people with and without aphasia. PWA use gestures spontaneously for communicative purposes and to compensate for their verbal difficulties, especially when communicative demands increase.

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# Restoration of both conceptual knowledge and word form retrieval in a case of semantic dementia in two compared treatments

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## Introduction

Research on the efficacy of treatment for anomia in *semantic dementia* has demonstrated that word retrieval could be improved (for a review, see Suarez-Gonzalez et al., 2015). However, since the reported improvements mainly concerned *naming* tasks, which cognitive processes were restored remains unclear: semantic representations, access to word forms, or both ? In the single-case study (DP) we report here, we addressed this issue by investigating whether *both* comprehension and naming can be improved, with an *errorless anomia treatment* (Jokel & Anderson, 2012) *recruiting remaining personal semantic memories* (Savage, Ballard, Piguet, & Hodges, 2013; Suarez-Gonzalez et al., 2015). We also compared the treatment efficacy (immediate benefits, generalisation, maintenance) when the *patient was trained with a therapist all along versus when he was in half sessions by himself.*

### *Case report*

DP was a retired right-handed man, 67 years old when this study started (March 2015), with an engineering degree, presenting with a semantic dementia (diagnosis established in 2013 following Gorno-Tempini et al. (2011) diagnostic criteria for semantic dementia) associated with a significant atrophy of the left anterior temporal lobe, and characterized by a semantic deficit, a severe anomia, and a surface dysgraphia. Reading and repetition of words, nonwords, and sentences, as well as oral and written sentence comprehension were preserved. Moreover, the neuropsychological examination carried out in March 2015 revealed that short-term memory, both verbal and spatial, visual long-term memory, numerical knowledge and processing, were spared, as well as praxic, attention and executive functions.

## Methods

*Material*. Two lists (L1 and L2) of 32 personally familiar items (food and office objects) matched for word frequency, concept familiarity and initial performance in naming and comprehension were constituted.
*Training procedure.* Two types of intensive training (TL1 and TL2), 16 sessions each, were sequentially proposed to DP: training (L1) with a therapist all along followed by training (L2) alternatively with and without the therapist (8 sessions each).
In both cases, the (computer) training procedure was an errorless lexical and conceptual enrichment training (ELCOENT) in 5 steps adapted from Savage et al. (2013) and Suarez-Gonzalez et al. (2015).
*Measures of the training effects.* The efficacy of the two types of training was measured with cognitive baselines (naming *and* property verification tasks) and with generalisation tasks (naming tasks with the same items but different pictures), administered immediately and after 1-3-6 months for maintenance evaluation.

## Results

As displayed in Figure 1, the two types of training (TL1 and TL2) had equivalent significant benefit after the treatment phase, with equally high levels of performance in naming and comprehension tasks (all $p < 0.001$). However, the first type of training was more efficient both in terms of generalisation and maintenance of the improvement at the follow-up baselines, as revealed by a better performance for L1 than for L2 in the naming tasks ($0.001 < p < 0.025$ Finally, the restored conceptual representations were better maintained than access to lexical forms in both types of training (both $p < 0.01$).

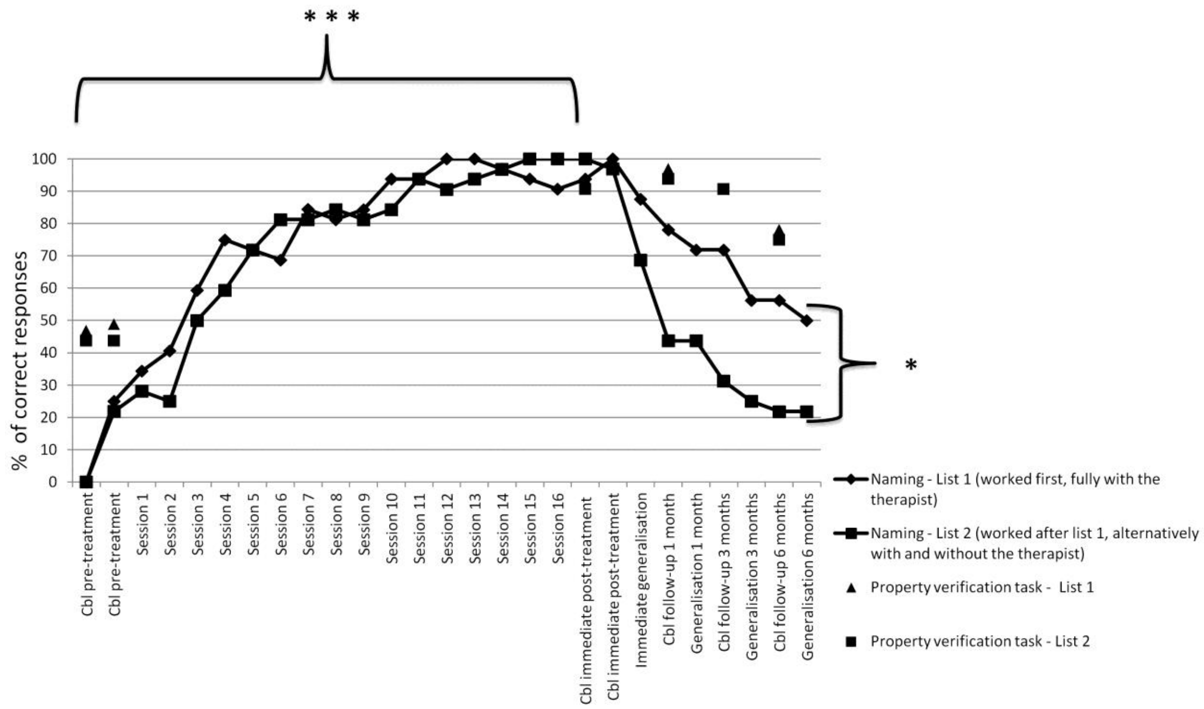


Figure 1. DP's percentage of correct responses in naming and comprehension tasks in the cognitive baselines (cbl) pre- and post-treatment, in the measurements during training sessions, and in the generalisation tasks. *** : significant improvement in the two types of training ($p< 0.001$). *: significant differences between the two types of training in terms of generalisation and maintenance of benefit ($0.001 < p < 0.025$).

# Discussion

To the best of our knowledge, this is the first empirical evidence of (1) the efficacy of an ELCOENT on comprehension and naming in semantic dementia, suggesting a *restoration of both semantic and word form retrieval processing,* (2) advantages of *a fully-accompanied training in semantic dementia.* Further studies would be necessary to confirm these preliminary findings with a greater number of patients presenting with a semantic dementia, and to clarify the different neural mechanisms guiding this semantic and word form learning.

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# Typicality advantage for *exemplars* in picture naming and word-picture matching. Evidence from a case study of semantic variant of PPA

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## Introduction

In healthy speakers, successful naming can be modulated by intrinsic properties of these objects. Coherently, the greater case of impaired access to conceptual information is observed in patients suffering from semantic dementia (SD) or semantic variant of primary progressive aphasia (sv-PPA) (Adlam et al., 2006). Their impairments have been related to a progressive atrophy of anterior temporal lobes (Garrard & Hodges, 2000; Patterson et al. 2007) which is therefore thought to mediate the binding of object conceptual features.
Indeed, several studies showed that these patients have difficulties in naming and categorizing when dealing with typicality of objects or words (see Patterson, 2007). Patients tend to fail in considering atypical representations of objects as correct members of one category (relatively to prototypes) (Lambon-Ralph et al. 2010). Note though that little is known as to whether such difficulties are restricted to visual recognition, conceptual processing or distributed across other encoding stages during object naming.
Investigating the issue of object typicality faces the problem of the levels at which typicality is manipulated. For instance, patients can be presented with pictures of a penguin or a robin, that are respectively atypical and typical instances of the category of birds (Rogers et al. 2015), and their ability to name it is generally more impaired for atypical objects. Yet, is this impairment valid at all categorical levels? In the present study, we sought to address this issue by exploring the influence of the degree of typicality of *exemplars* in several tasks including picture naming and word-picture matching in a patient suffering from sv-PPA.
We first constructed a database of pictures of the same objects but varying in typicality. Moreover, we investigated further the properties of typicality and their influence in picture naming with colored pictures, black-and-white pictures and drawings of the same objects under the assumption that drawings are prototypical representations of objects and should be better processed in patients with progressive loss of conceptual features.

## Methods

### *Database construction*

Norms were obtained for 5 photographs of 146 different target objects and entities from the living (71 items) and non-living (75 items) domains and including various categories such as fruits/vegetables or manufactured objects on name agreement, picture familiarity, visual complexity and image agreement. A total of 204 French speaking volunteers (aged 18-52 years) participated in the various ratings.
Typicality seemed better expressed by image agreement (the degree to which a picture matches one's mental representation of the object) and the H statistic of the name agreement (number of alternates given for a target picture). Here, we used two sets of typical (high image agreement) and atypical (low image agreement) representations of the same objects, matched on the H name agreement (and visual complexity) such that the same name was expected for both representations.

### *Procedure*

In the colored picture naming task, 50 pictures of typical and atypical representations of the same objects were used. The presentation of stimuli was controlled manually by an experimenter who triggered the next trial if no response was given within 5000 ms.

The word-picture matching task included 100 trials with 67 congruent trials and 33 incongruent trials presented randomly. In congruent trials, the word category CAT was followed by the picture of "cat" which was either a typical (30 trials) or an atypical representation (37 trials).

An additional picture naming task was conducted with only typical representations which varied as a function of "visual" properties. The task included 44 colored pictures of the database, these same pictures transformed into black and white and their corresponding drawings from two French databases (Alario & Ferrand, 1999; Bonin et al., 2003).

### *Participants*

One French speaking woman (69 years), displaying a bilateral temporal pole atrophy (with mild right hemisphere superiority) and diagnosed with probable sv-PPA participated in the study. The colored picture naming task was conducted twice with 2 months' interval.

Five control subjects matched on age were also included.

## Results

In the picture naming task, the patient produced significantly less correct responses for atypical representations of objects (43%) compared to typical representations (72%, $\chi 2(1, N=150) = 13.19$, $p<.001$). No effect was found in control subjects with respectively 94% and 90% of correct responses for typical and atypical objects representations. The overall performance of the patient decreased in two months ($\chi 2(1, N=150) = 4.92$, $p<.05$) and the advantage for typical representations was observed at the first (84% vs. 56% correct responses, $\chi 2(1, N=50) = 4.67$, $p<.05$) and second test (66% vs. 36%, $\chi 2(1, N=100) = 9.00$, $p<.05$). t-test of Crawford-Howell for case-control comparisons (Crawford et Howell (1998) were used to demonstrate that patient's performance was pathological. An advantage of typical representations of objects in the patient was also found in the word-picture matching task with 84% of correct responses for typical representations and 37% for atypical representations ($\chi 2(1, N=132)=10.69$, $p<.005$). No effect was found in control subjects. Finally, for the picture naming task of colored vs. black and white pictures vs. drawings, the performance of the patient was generally decreased compared to the performance of control subjects (73% vs. 95%, $t(4)=-6.930$, $p<.001$) but there was no effect of the visual properties of pictures.

## Discussion

Coherent with previous findings (Rogers et al. 2015), the present study reveals a typicality advantage in conceptual processing, which is verified at the level of exemplars, both in picture naming and in word-picture matching. Our results indicate that the patient was more affected by exemplar typicality than control subjects, which is likely due to the atrophy of anterior temporal lobes. We also showed that the impairment in object naming increases rapidly (Hodges et al. 1995), and that the typicality advantage maintains across time. Note though, the absence of advantage in naming drawings compared to colored pictures of the same objects tackles the issue of what constitutes the typicality advantage in patients and at which processing stage of speech planning it intervenes. An event-related potentials (ERPs) study in healthy speakers is currently under analysis to investigate this issue.

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# Bimodal language in post-ictal aphasia

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## Introduction

A pathological model of language deficits is drug-resistant epilepsy, which is known to induce impairments in verbal memory, naming or spontaneous speech. These are typically described between epileptic seizures (i.e. in inter-ictal states; Bartha-Doering, 2014, Baciu, 2015). Drug-resistant epilepsy patients also show substantial language deficits like anomia during the seizures and in the periods following them, called post-ictal states. Such post-ictal aphasia episodes have received very little attention and were the focus of our research.
We investigated jointly the production of speech and co-verbal gestures, owing to the multi-modal nature of conversation and verbal interactions, where information is conveyed by the integration of multiple signals (speech, posture, gaze, facial expressions, co-verbal gestures, etc.). Our investigation was mostly empirical, addressing the following open questions: Is the production of co-verbal gestures modified during post-ictal states? If yes, how does it change? Is there a difference between frontal *versus* temporal lobe seizures?

## Methods

### *Patients*

We tested 12 drug-resistant epileptic patients (6 females), all native speakers of French. The patients had a mean age of 36 years and IQ above 80. They were all right-handed, with left hemisphere language dominance. They were tested during pre-surgical investigation therefore under drug restriction and with surface and intra-cerebral activity constantly monitored. They were videotaped round-the-clock. We gathered data from a total of 21 seizures inducing post-ictal language deficits. Seven of them originated from left fronto-insular lobe and 14 started from left anterior-basal temporal lobe.

### *Experimental Design*

The main purpose of the experimental protocol was to induce multimodal communication based on speech and co-verbal gestures. The task consisted in presenting highly detailed pictures to be memorized within 30 seconds. The pictures depicted complex scenes in which there were different characters, interactions, objects, etc. The patients were tested in inter-ictal and in post-ictal conditions. The latter are defined as the 5 to 10 minutes following the end of a seizure. Before the experimental task, various language performance measures were recorded in post-ictal state (naming, repetition, apraxia, reading, executive functions).

### *Behavioral analysis*

We analyzed video recordings using ELAN (EUDICO Linguistic ANnotator; Max Planck Institute for Psycholinguistics, 2002). We quantified the verbal flow in words per second and identified language disfluencies based on hesitations and interrupted words. Gesture units were defined as the duration from the start of a movement to a return to resting position, or to a pause in the movement, or to a change in shape or trajectory (McNeill, 1992). We excluded non-communication gestures (e.g. touching the face, changing posture or hands position, recreational gestures, etc.) because of their lack of semantic content.

Each detected co-verbal gesture was classified based on an annotation guide including eight forms of gestures (McNeill, 1992; Tellier, 2011), two which we added a two super-ordinate categories: "illustrative" and "rhythmic". "Rhythmic" gestures are produced in support of speech building, presumably for the benefit of the speaker. "Illustrative" gestures are produced to illustrate the speaker's speech, presumably for the benefit of the interlocutor's comprehension. For both verbal and gesture analysis, we took into account the number, duration and frequencies of the events.

### *Implication of brain areas in seizures*

Areas involved in seizures are defined by the analysis of SEEG-video, EEG-video recordings, fMRI, PET scan and semiology. For each seizure of each patient, we obtained the epileptogenic zone (EZ) and the propagation network (PN). To simplify anatomical variables, each the left fronto-temporal area is divided in 5 sub-regions: anterior temporal (LTA), posterior temporal (LTP), temporo-basal (LTB), insular (LI) and inferior frontal (LF).

## Results

We observed 70% of changes in verbal flow and 75% of changes in gesture production between the inter-ictal *versus* post-ictal conditions. There were contrasting communication patterns between patients suffering from left temporal epilepsy (LTE) *versus* left fronto-insular epilepsy (LFIE). In short, LTE patients showed a decrease of verbal flow along with an increase in "rhythmic" gesture production, and no change in "illustrative" gestures. LFIE patients did not show changes in verbal flow, but a global decrease of co-verbal gesture production. Details are provided in the poster.

## Discussion

The aim of our study was to quantify the use of co-verbal gestures linked to speech in an aphasic post-ictal state. Co-verbal gesture use and disfluencies showed a significant difference between the inter-ictal (control) condition and the post-ictal (impaired) condition. More specifically, we observed significant evidence of decreased verbal flow combined to an increase of "rhythmic" gestures production in LTE patients in post-icital versus inter-ictal conditions. Decreased verbal flow is congruent with previous evidence of language impairment in LTE patients (Privitera & Kim, 2010) and in lexical access (Trebuchon et al., 2009). We also found that gesture production changes differently depending on gesture category. Due to disparity of gesture classifications in the existing linguistic literature, this result is difficult to compare to others. Nevertheless, it interestingly reflects modification in co-verbal gesture use strategy in both conditions. In addition, an increase in "rhythmic" gesture production, presumably produced for the benefit of the speaker, associated to decrease of verbal flow and no variation in "illustrative" gesture use, may demonstrate a specific facilitation by "rhythmic" gesture during impairments in lexical access (Krauss, 2000). Furthermore, the communication pattern of LFIE patients was without changes in verbal flow but showed a global decrease of co-verbal gesture use. The stable verbal flow can be explained by testing delay; it has been previously shown that LFIE patients retrieve faster linguistic skills than LTE patients (Goldberg-Stern et al., 2004). Interestingly, our data highlight different communication patterns depending on areas involved in the seizure. This could indicate differences in communication strategies linked to intrinsic chronic plasticity induced by epilepsy in different locations.

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| | LTE | LFIE |
|---|---|---|
| ***Verbal flow*** | * | |
| | | |
| **Deictic** | | *** |
| **Iconic** | | |
| **Metaphoric** | | |
| **Emblem** | | |
| ***Illustrative*** | | ** |
| | | |
| **Beat** | ** | |
| **Butterworth** | | * |
| **Aborted** | | * |
| **Other** | | |
| ***Rhythmic*** | ** | *** |

Table 1: Variation of co-verbal gesture production and verbal flow between the inter-ictal and post-ictal conditions.
Green denotes an increase in post-ictal versus inter-ictal conditions; Red denotes a decrease in post-ictal versus inter-ictal conditions. Stars indicate significance levels: p<=0.05: *, p<=0.01:**, p<=0.001:***. LTE: left temporal lobe epilepsy; LFIE: left fronto-insular epilepsy.
The gesture labels are from McNeill (1992) and Tellier (2011).

# Bidirectional interference effects in a verbal and non-verbal dual-task paradigm

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## Introduction

Current models and studies on word planning (typically in word naming tasks) suggest that speech production requires some non-verbal cognitive abilities, upon which attention (Roelofs, 1997) and executive functions (Ferreira & Pashler, 2002). In other language production tasks, it also has been observed that performances could deteriorate in several aspects under dual task conditions (Jou & Harris, 1992), nevertheless the status of interference in automatic speech activities is not clear. In addition, the lack of systematic evaluation of bidirectional interference (both first and concurrent tasks on one another) imposes limits to the understanding of resource sharing between verbal and non-verbal processes. We also know that there is a certain degree of flexibility on task priorisation between speech and a concurrent task (Kemper et al, 2011), that strengthens the need for a complete picture of interference effects between two tasks. Thus, we wanted to investigate the bidirectional interference effects in verbal and non-verbal performances in a dual task-paradigm using attention and executive function concurrent tasks, and a semi-automatic verbal production task.

## Methods

### *Population and tasks*

Data from 61 adults from 5 age-groups (18-35; 36-48, 49-55, 56-65, 66 and older) were included in this study. All of them were French speakers and had no history of neurological or language disorder. A verbal task and two non-verbal computerized tasks (attention, inhibition) were used. In the verbal task, participants performed a loop-recitation of days of the week. In the attentional task (Go), they had to respond manually to a shape on a screen as fast as they could. In the inhibition task (GoNoGo), they had to manually respond to one shape out of two as fast as they could. Each task was realized on single (speech, Go, GoNoGo) and dual conditions (speech + Go ; speech + GoNoGo). Two versions of the experiment were built to minimize bias in order of presentation (reversing Go and GoNoGo presentation order).

### *Measures*

We measured two verbal and one non-verbal scores: global speech rate (number of days in each week / duration of the week), articulation rate (number of syllables in each “Wednesday-Thursday” / duration of “Wednesday-Thursday”), reaction time (in attention and inhibition tasks). Each of these measures was averaged for each participant and each condition (single or dual). On this basis, we calculated an Interference Score (IS) for each variable as follows: (dual - single) / single scores. In our view, this score represents the cost (or potentially the facilitation) of completing one task in dual-task situation (in comparison to the score in single-task situation).

## Results

For each dependent variable Interference Score (IS), a repeated measures ANOVA was conducted with type of non-verbal task (Go vs GoNoGo) as within factor, age group, sex, and order of presentation of the tasks as between factors.

We observed a significant main effect of task for each variable. Global speech rate IS (F(60)=9.98, p<.01) and articulation rate IS (F(60)=18.61, p<.001) were significantly more altered with the concurrent GoNoGo task than with the Go task. Reaction times IS was significantly more altered for the Go task than for the GoNoGo task (F(60)=197.44, p<.001). For both speech variables, task interacted with order of presentation (Global speechrate: F(60)=9.22, p<.01 ; Articulation rate: F(60)=5.01; p<.05) as such as a difference of IS between the two speech + non-verbal interferent tasks was found only when GoNoGo were presented first (before Go task). For reaction times, task interacted with sex (F(60)=18.13, p<.001) showing that men presented more interference than women during Go task (both showing more deterioration in the Go task than the GoNoGo). No significant effect of age-group were found in any of our three variables IS.

# Discussion

This study used a dual-task paradigm to investigate possible trade-off between verbal and non-verbal resources in a (semi-automatic) language task. We showed that when doing a semi-automatic speech task and a concurrent non-verbal task, interference does not occur unidirectionally. Specifically, we observed a pattern of enhanced interference with a concurrent inhibition task (GoNoGo) compared to an attentional task (Go) on speech rate measures. This effect was reversed when analyzing interference of speech on the cognitive tasks (reaction times), where slowing was more important for the attentional task (Go) than for the inhibition task (GoNoGo). These results could support the hypothesis of differential resources allocation following the task, making reversed interference effects. More concretely, participants could engage more resources on speech during the attentional task and focus more on decision and manual response during the inhibition task. The mechanisms responsible of possible changes in resource allocation and the conditions of such effects have to be further explored by taking systematically into account the bidirectional effects when analyzing dual tasks performances.

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# Verbal Fluency in Aphasia: Temporal Changes in Clustering and Switching

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## Introduction

Verbal fluency tasks are frequently used to investigate cognitive and linguistic abilities of clinical populations, and are included in a broad range of aphasia assessments. In this task, individuals are asked to produce as many words as possible within 60 seconds, according to a given cue (e.g., animal names, words beginning with a specific letter). Successful verbal fluency performance requires two retrieval strategies, clustering and switching. Clustering involves retrieving semantically related words in specific subcategories and is thought to reflect the strength of associative links among words (i.e., organization of the lexicon). In contrast, switching involves shifting to a new category after a subcategory has been exhausted and is thought to rely more on executive control processes (Troyer et al., 1997). While people with aphasia (PWA) are known to produce fewer words in verbal fluency tasks, it is unclear whether their limited output is due solely to lexical retrieval difficulties or may in part be due to reduced executive control abilities. To date, few studies have investigated both quantitative (i.e., number of words) and qualitative (i.e., clustering, switching) aspects of verbal fluency performance in aphasia (Baldo et al., 2001; Kiran et al., 2014; Sarno et al., 2005). Moreover, the temporal characteristics of word retrieval during this task may also shed light on the above debate (Adams et al., 1999; Bose et al., 2017). The goal of the current study was to examine differences in clustering and switching, reflecting linguistic and executive control abilities, respectively, as a function of time between PWA, stroke patients without aphasia, and healthy older adults.

## Methods

### *Participants*

Verbal fluency performance in 8 PWA was compared to that of 7 stroke patients without aphasia (PNA), and 30 healthy older adults (OA). Inclusion criteria for PWA were: single left hemisphere stroke, aphasia diagnosis based on the Western Aphasia Battery-Revised (Kertesz, 2006), at least 9 months post-stroke, monolingual English speaker, no history of other neurological illness, psychiatric disorder or substance abuse, and no other significant sensory and/or cognitive impairments that could interfere with completing the study. PNA met these same inclusion criteria, except that they did not have aphasia. OA were native monolingual English speakers with no reported history of speech, language or hearing problems, any neurological disease or major health problems.

### *Procedure*

For the verbal fluency task, participants were asked to generate the names of as many animals as they could within 60 seconds. Responses were recorded with a high-quality digital recorder, transferred to computer, and then time stamped. The 60-second period was divided into four intervals of 15 seconds each. Incorrect responses (e.g., nonwords, non-animal names, unintelligible responses) were excluded prior to data analysis. Repetitions of animal names were excluded in calculating the number of correct responses, but were included in calculating clusters and switches, as they are thought to be indicative of underlying cognitive processes (Troyer et al., 1997). The number of correct words, cluster size, number of switches, and within- and between-cluster pauses were evaluated as a function of the four time intervals. Detailed procedures for clustering and switching analyses were based on previous research (Bose et al., 2017; Troyer et al., 1997). Scoring of each participant's responses was conducted independently by two individuals and interobserver reliability was found to be very high.

## Results

The data were analyzed using a repeated measures ANOVA with Group (PWA, PNA, OA) as a between-subject factor and time interval (15, 30, 45, and 60 seconds) as a within-subject factor. Compared to OA, both PWA and PNA produced fewer total correct words. In addition, PWA had a smaller mean cluster size and fewer switches between animal subcategories than OA. With respect to the temporal pattern of responses, all groups showed decreased productivity in the number of words over time, but PWA and PNA reached the asymptote earlier in the time course, typically after the first 15 seconds. Although the stroke participants with and without aphasia were similar in this respect, PWA did produce fewer words than PNA during most time periods. For all groups, mean cluster size also decreased over time as did the number of switches between subcategories, although PWA produced very few switches after the first 15 seconds.

## Discussion

The above findings suggest that people with aphasia have more effortful word retrieval and a decreased ability to shift between categories during the verbal fluency task. These claims are supported by slowed word retrieval times and fewer total words and switches over time in people with aphasia compared to older adults. The current results provide evidence that verbal fluency impairments in aphasia are due in part to lexical retrieval difficulties and reduced executive control abilities. Clinicians and researchers may need to reconsider how verbal fluency performance in aphasia is interpreted, as it does not always necessarily reflect a purely linguistic deficit.

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# Lexical Diversity in Different Types of Aphasia

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## Introduction

Analysis of lexical devices is an important part of assessment of discourse production skills in various clinical populations. Lexical diversity (LD) is the most widely used measure to investigate verbal skills of any specific population or individual, measuring the number of different lexemes used in a speech sample. In this study we apply several measures of LD to narratives by speakers with different types of aphasia and neurologically healthy speakers from the Russian CliPS corpus (Khudyakova et al., 2016).
Previous studies of discourse in aphasia has shown that diversity of all lexical devices in lower in texts by people with aphasia (PWA) compared to neurologically healthy speakers (Fergadiotis & Wright, 2011), as well as diversity of nouns and verbs (Bastiaanse, 2011; Bastiaanse & Jonkers, 1998; MacWhinney, Fromm, Holland, Forbes, & Wright, 2010). We calculate LD using methods that have been proven to be a valid measure for narrative discourse in aphasia (Fergadiotis, Wright, & West, 2013): MTLD (measure of textual lexical diversity) and MATTR (moving average type-token ratio) with two different window sizes.

## Methods

### *Material*

Russian CliPS is a collection of Pear film (Chafe, 1980) retellings by people with aphasia and right hemisphere damage, as well as neurologically healthy speakers of Russian. The types of aphasia of the brain-damaged speakers were established using Luria's classification (Akhutina, 2015; Luria, 1966). The four aphasia types present in the corpus include two with non-fluent speech output (efferent motor and dynamic aphasias) and two with fluent speech output (sensory and acoustic-mnestic aphasias). For this study we have analyzed 59 texts from the Russia CliPS corpus: 21 narratives by healthy speakers and 38 stories by PWA (10 speakers with efferent motor aphasia, 9 – dynamic aphasia, 10 – acoustic-mnestic aphasia, and 9 – sensory aphasia).
The narratives are transcribed in ELAN Annotation tool (Wittenburg, Brugman, Russel, Klassmann, & Sloetjes, 2006), and the analysis of LD was applied to the lemma tier. False-starts (unsuccessful attempts to produce a word) and filled pauses are not reflected on the lemma tier and were not included in the analysis.

### *Lexical Diversity Measures*

As shown by Fergadiotis et al. (2013), MTLD and MATTR are valid measures of LD and reflect little of any other text parameters. However, the size of the window of MATTR is a parameter that can influence the results and interpretations of the output: small window size can detect such properties of the text, as frequent repetitions, while a greater window size is not sensitive to such features (Covington & McFall, 2010). In this study we run MATTR with two different window sizes : 10 and 100, hypothesizing that MATTR with the smaller window might be sensitive enough to detect the differences between fluent and non-fluent types of aphasia.
Lexical diversity analysis was performed in R with koRpus package (Michalke, 2017).

## Results

The results of the LD analysis are summarized in Table 1. One-way ANOVAs and posthoc Tukey HSD tests were run separately for every LD measure, and a significant difference was found between texts by healthy speakers and all PWA groups ($p < 0,05$), with PWA having lower LD than healthy speakers. Also for MATTR with a short window (=10) we have found a significantly ($p < 0,05$) lower LD score of people with dynamic aphasia as compared to people with fluent types (acoustic-mnestic and sensory aphasia).

# Discussion

The results of the study go in line with the previous findings, showing that people with different types of aphasia have lower LD scores than healthy speakers. We have also shown that applying a specific measure of LD – MATTR with a smaller window size can detect differences between texts by speakers with dynamic aphasia and fluent aphasia types.

*Table 1. Results of the LD analysis*

| Group | Tokens | | Types | | MTLD | | MATTR (window = 100) | | MATTR (window = 10) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **mean** | **SD** | **mean** | **SD** | **mean** | **SD** | **mean** | **SD** | **mean** | **SD** |
| Speakers with acoustic-mnestic aphasia (N = 10) | 268,0 | 118,8 | 111,8 | 33,1 | 38,0 | 7,6 | 0,6 | 0,0 | 0,9 | 0,0 |
| Speakers with dynamic aphasia (N = 9) | 192,1 | 74,0 | 74,4 | 14,0 | 23,5 | 14,5 | 0,5 | 0,1 | 0,8 | 0,1 |
| Speakers with efferent motor aphasia (N = 10) | 225,3 | 119,8 | 93,9 | 39,2 | 28,9 | 9,7 | 0,5 | 0,1 | 0,9 | 0,0 |
| Speakers with sensory aphasia (N = 9) | 287,3 | 130,3 | 107,1 | 37,2 | 32,7 | 11,0 | 0,6 | 0,1 | 0,9 | 0,0 |
| Healthy speakers (N = 21) | 258,6 | 108,1 | 129,8 | 39,8 | 66,3 | 20,8 | 0,7 | 0,0 | 0,9 | 0,0 |

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# Phonemic and semantic paraphasias in acute aphasic patients – a voxelwise lesion-behavior mapping study

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## Introduction

The analysis of error types in language production, such as phonemic and semantic paraphasia, provides useful information about the stages and processes involved in normal and aphasic speech. In this study, we performed lesion-behaviour analyses in acute left-hemisphere-damaged aphasic patients in order to determine whether there was spatial proximity or overlap among the voxels associated with these error types. This study used the new lesion analysis technique known as contingency tables to investigate the locus of lesions that give rise to semantic, phonemic or both error types. We also investigated the involvement of white matter tracts to the presence of semantic and phonemic paraphasias.

## Methods

We included 105 patients (mean age 64 y, 74 male) who suffered from aphasia, caused by an acute ischemia in the territory of the left middle cerebral artery. Patients were examined 4 (+/-3) days after stroke onset. Behaviourally, they were tested with a standardized aphasia test battery. The patient's language production during spontaneous speech samples was evaluated for the presence of phonemic and semantic paraphasias. Structural MRI included DWI, FLAIR and a high-resolution T1 anatomical scan. Lesions were delineated on the DWI or FLAIR scans. Binary individual lesion maps were normalized to the MNI space. The statistical analyses was performed via contingency tables in a voxel-wise manner. For every voxel the likelihood ratio tests were performed for multi-dimensional contingency tables (Haberman, 1972) with the dimensions semantic paraphasias (existent vs. non-existent), phonemic paraphasias (existent vs. non-existent), and lesion (voxel lesioned vs non-lesioned). The likelihood ratio tests allow detecting test significant deviations of two or more. In order to identify the involvement of language specific fiber tracts, we overlapped the statistical lesion maps for phonemic and semantic paraphasias, respectively, with language associated white matter fiber tracts reported in a previous study (Egger et al., 2015).

## Results

Patients speech errors were classified into phonemic paraphasias (n=48), semantic paraphasias (n=18), both types of paraphasia (n=23) and no paraphasia (n=16).
Phonemic errors were mostly associated with lesions within the middle and posterior part of the middle and superior temporal gyrus and the supramarginal gyrus. Semantic errors were most frequently affected by lesions within the middle and anterior parts of the superior and middle temporal gyrus, extending to the anterior lobe. Both lesion maps overlapped in the superior temporal lobe. An investigation of white matter damage revealed the middle longitudinal fascicle (MdLF) being involved in both error types.

## Discussion

These results, from a large group of stroke patients, provide direct lesion evidence for both common and diverse lesion sites for the different paraphasia types. Our results are in line with previous studies showing a segregation of brain regions being associated with phonological and semantic processing (DeWitt and Rauschecker, 2015; Hickok and Poeppel, 2004; Lambon Ralph et al. 2017; Schwartz et al. 2012).
Being associated with the lesion maps of both paraphasia types, we were also able to demonstrate the relevance of the MdLF in language processing. The MdLF originates in the posterior superior temporal and parietal lobe, producing terminations along the course of the temporal cortex to the temporal pole (Makris

et al. 2016). Its role in language processing is still under debate (Tremblay and Dick 2016), although recent studies suggest that the MdLF is relevant for language processing, e.g. for language comprehension (Turken & Dronkers, 2011; Saur et al., 2008).

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# Phonological cueing in picture naming: first phoneme cohort size effects in healthy and aphasic speakers

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## Introduction

Although phonological cueing is a frequently used treatment for aphasia to facilitate word retrieval, the mechanisms underlying facilitation are still unsung. Different explanatory assumptions co-exist: ***1. the lexical hypothesis,*** which suggests that the phonological cue acts at the lexical level thought the activation of all lexical entries phonologically consistent with the supplied cue (here cohort of words beginning with the phoneme) (Marslen-Wilson & Welsh, 1978; Starreveld & La Heij, 1995, 1996); ***2. The sub-lexical hypothesis***, holding that a phonological cue acts at phonological level (Lee & Thompson, 2015) by pre-activating the phonemes shared with the target word (Wunderlich & Ziegler, 2011). 3. ***The hybrid hypothesis*** (Roelofs, Meyer, & Levelt, 1996) in favour of an action at both, the lexical and phonological levels.

The purpose of this work is to shed light on the mechanisms underlying phonological facilitation by investigating the effect of the size of the cohorts of words beginning with the same first phoneme of the cue (“word onset cohort”) on phonological facilitation. This manipulation should shed light on the origin of facilitation by phonological cues: a larger facilitation for cues activating few lexical candidates (reduced word onset cohort size) relative to cues corresponding to large word onset cohort size may support the lexical hypothesis.

## Methods

### Participants

*Heathy speakers - Experiment 1 a. (Noun cohort size) & 1.b. (Verb cohort size).* 27 undergraduate students native French speakers from the University of Geneva aged between 19 and 38 year-old (mean: 22.6) performed this task.

*Aphasic speakers - Experiment 2 (Noun cohort size)* – 18 aphasic participants aged between 43 to 89 years old (mean=66) and suffering from aphasia following focal left hemisphere damage have been enrolled up to now. 6 patients presented a larger propensity to semantic errors while 6 others have higher phonological error rate.

### Material and task

*In experiment 1 a. and b.* Healthy subjects were tested in a noun (1.a.) and verb (1.b.) picture naming task with 48 black and white line drawings in the noun experiment and 24 in the verb experiment preceded by a phonological cue. Cues consisted of a consonant (C) + schwa delivered auditively in three conditions: Matching cue-target (eg. [bC] for *bison*) – Control (picture naming without cue) - Mismatching cue-target condition (used as filler items and not analyzed). The cues corresponded either to phonemes corresponding to low word onset frequency for nouns for verbs (i.e. to a reduced word onset cohort) or to high word onset frequency (i.e. to a large word onset cohort).

*In experiment 2.* Aphasic participants performed a noun picture naming task of 38 black and white line drawings with phonological cues delivered via audio-visual video clips (person pronouncing the first phoneme of the picture to name). The same conditions as in experiment 1 were manipulated, namely the cueing conditions (control, matching and mismatching) and the word cohort size corresponding to the cue (large versus reduced word onset cohort size).

# Results

*On healthy subjects*, in experiment 1.a. (noun cohort size), results of a mixed effects regression model on latency data revealed a main effect of the cueing condition (F=(1,1997.1)=12.95,p<0.001), and a significant interaction between the cueing condition and the noun onset cohort size (F=(1,1998.4)=9.30,p=0.002) with a larger facilitation after a cue corresponding to a reduced noun onset cohort than a large cohort.
In experiment 2.b. (verb cohort size), a significant interaction between the cueing condition and the verb onset cohort size (F=(1,868.44)=5.34,p=0.02*) with a larger facilitation for the reduced verb cohort cue than a large verb onset cohort.
*On aphasic speakers,* preliminary results obtained on naming latencies for the 18 aphasic speakers showed a main effect of the word onset cohort size (F=1,161)=3.75, p=0.01), of the cuing condition (F=1, 638.6)=12.54, p<0.001), and a significant interaction between the condition and the word onset cohort size (F=(1,638.1)=9.6, p=0.002), and between the condition and the error profile (F=(1,636.9)=7.5, p=0.006). On the 6 aphasic participants with a lexical-semantic error profile, a main effect of the condition is observed on latencies (F=(1, 288.6)=4.32, p=0.04) but no effect of the onset cohort size, and no significant interaction between the cohort size and the condition. On the 6 phonological error profile patients, a main effect of the condition (t(316.1)=3.03, p=0.003) and a significant interaction between the cohort size and the condition (t(316.4)=-3.41, p<0.001) with facilitation after a reduced word cohort cue and interference after a large word onset cohort cue.

# Discussion

In view of these first results, both, healthy and aphasic subjects are sensitive to phonological facilitation on latencies. In healthy subjects (exp 1.a.&b.), this effect is modulated by the word onset cohort size associated with larger facilitation when the cue corresponds to a reduced lexical cohort than when it corresponds to a large cohort. This effect is observed for nouns and for verbs and favors a lexical locus of the effect of phonological cueing. On aphasic participants, the facilitation effect varies according to the patient profile: while semantic patients are facilitated by the cue independently of the onset lexical cohort, patients with phonological profile showed a larger facilitation effect when the cue corresponds to a reduced lexical cohort than when it corresponds to a large cohort.
Taken together, these results are in the line with a lexical locus of the phonological cue effect in particular since the effect is modulated by the size of the lexical cohort corresponding to the grammatical class of the target word in exp 1a and 1b. Under this interpretation, the reason why only aphasic participants with a phonological profile are affected by the word cohort size, whereas patients with lexico-semantic impairment not needs to be further investigated, and we are currently including other participants.

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# Revisiting The Public Awareness of Aphasia in Exeter: 15 Years On

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## Introduction

Surveys in public places around the world have attempted to assess the public awareness of aphasia (eg., Code et al., 2001, 2016; Simmons Mackie et al., 2002). Our recent international surveys (Code et al., 2016) found a wide range of awareness with 57.4% in Norway saying they had 'heard of aphasia' but with 13.9% having basic knowledge, contrasting with Argentina where just 1% of 800 respondents had basic knowledge. Other findings included a higher rate of basic knowledge among females and a greater percentage of elderly claiming to have heard of aphasia, though basic knowledge was more common in younger respondents. The first of these studies surveyed 378 members of the public in Exeter, England (Code et al, 2001).

Since this 2001 study, there have been no significant attempts to raise awareness of aphasia in Exeter. From 2001 to 2011 the population of Exeter has increased by approximately 6% and a new generation have reached adulthood. Additionally, there has been an increase in people from other European countries and immigration from around the world. Fifteen years on we conducted a similar survey in Exeter to investigate whether knowledge of aphasia had improved. Along with the original survey, we also investigated the effects of country of origin/ethnicity on awareness. We also conducted further analysis of education and social class and asked questions on occupational and educational background. Finally, we compared awareness with a wider range of other neurological disorders affecting communication that have featured more heavily in the media in recent years, such as autism, stuttering and dyslexia.

## Methods

### *Participants*

Participants were a convenience sample of 167 individuals aged over eighteen surveyed in the same city-centre shopping centre in Exeter as in 2001 using an augmented form of the same questionnaire.

### *Procedure*

Surveyors were students instructed in basic survey techniques who asked respondents if they had heard of aphasia. For those who answered affirmatively, respondent was asked to identify characteristics of aphasia by choosing 'yes', 'no', or 'not sure' from a list of descriptors such as 'trouble with speech or pronunciation', 'trouble with thinking or intelligence', or 'communication problems'. A 'score' was determined for statistical analysis. Respondents were also asked what caused aphasia, and where they had heard of aphasia. In addition, the respondent's age, gender, occupation, educational history and cultural/ethnic background were requested.

For comparison, respondents were asked if they had heard of stuttering, dyslexia, autism and stroke, but responses were not scored or knowledge of these conditions tested.

## Results

We used a between-subjects design to examine results. Seventy-seven males (46.1%: 41% in 2001) and 90 females (53.9%: 59% in 2001) responded: ages ranged from 18 to 90 years (Mean 43.8 years, SD=17.8: in 2001 Mean 42.8, SD 18.7 Range 13–85).

The percentage who had heard of aphasia was still very low, as was the percentage with basic knowledge. In total 34.1% reported having heard of aphasia with only 5.4% demonstrating a basic knowledge. These results were compared to those reported in Exeter in 2001 where 18.25% had heard of aphasia and 7.67% had a basic knowledge. Comparatively, 92.8% had heard of dyslexia, 95.2% had heard of stammering, 97% had heard of autism and 95.2% had heard of stroke: each of these showed a markedly higher level of awareness than for aphasia (see Figure 1).

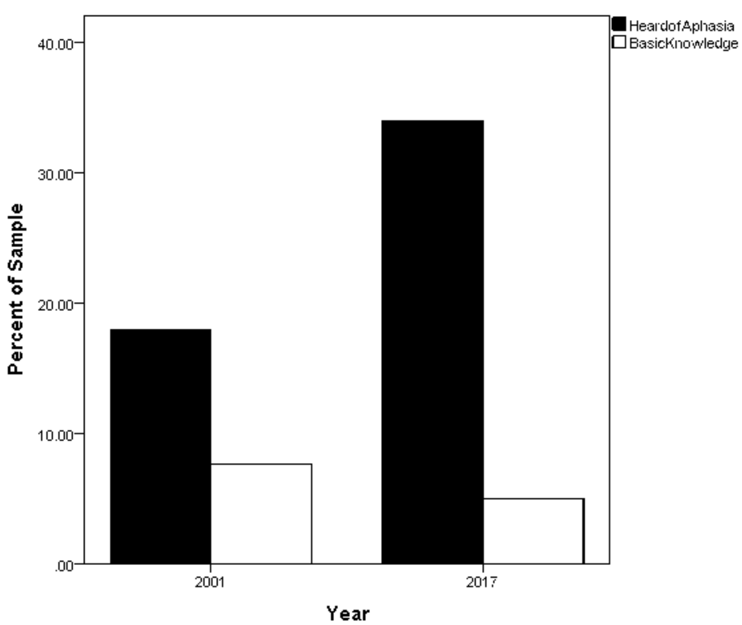


Figure 1. Percentage of respondents with awareness and knowledge of aphasia in 2001 and 2017.

Respondents were from a range of occupational groups: Group II (Intermediate professionals, 27.6%), Group IX (retired, 17.4%) and Group IV (skilled manual,13.2%). Group II were most likely to have heard of aphasia (52.2%) and also most likely to have basic knowledge (13%).

Similarly to findings from Code et al. (2001), females were more likely to have heard of aphasia and to have basic knowledge of aphasia. However, a multivariate analysis of variance (MANOVA) revealed that the effect of gender on both having heard of aphasia ($F(1,165) = 1.964$, $p = .163$, $\eta p^2 = .012$) and possessing a basic knowledge ($F(1,165) = 1.635$, $p = .203$, $\eta p^2 = .010$) failed to reach significance (see Table 1).

Table 1.
Numbers of respondents of each gender who had heard of aphasia and who had a basic knowledge.

| | Heard of aphasia (%) | Basic knowledge (%) |
|---|---|---|
| Male | 22 (39) | 3 (33) |
| Female | 35 (61) | 6 (67) |
| Totals | 57 | 9 |

Further MANOVA revealed no significant effects of age on either having heard of aphasia or possessing a basic knowledge. However, age was a significant predictor of the total aphasia score ($F(1,165) = 8.416$, $p = .004$, $R^2 = .049$).

An ANOVA of the effects the socio-economic group indicated a significant effect on having heard of aphasia ($F(8,158) = 2.094$, $p = .039$, $\eta p^2 = .096$), though not on having a basic knowledge. A MANOVA additionally showed that health professionals were significantly more likely to have heard of aphasia ($F(1,165) = 39.290$, $p < .001$, $\eta p^2 = .192$) and to have a basic knowledge ($F(1,165) = 24.925$, $p < .001$, $\eta p^2 = .131$) (see Figure 2).

In order to reflect the increasing cultural and ethnic diversity of Exeter since 2001, the effect of cultural identity, being born in the UK, and having English as a first language on having heard of aphasia and basic awareness were all investigated, though none of these reached significance. However, it is difficult to truly assess the effect of these variables as the number surveyed that were either not indigenous British or did not have English as a first language were very low.

We examined whether there was any association between knowledge of aphasia and the other conditions. Linear regression analyses revealed that only knowledge of stroke significantly predicted aphasia knowledge ($F(1,165) = 19.317$, $p < .001$, $R^2 = .009$).

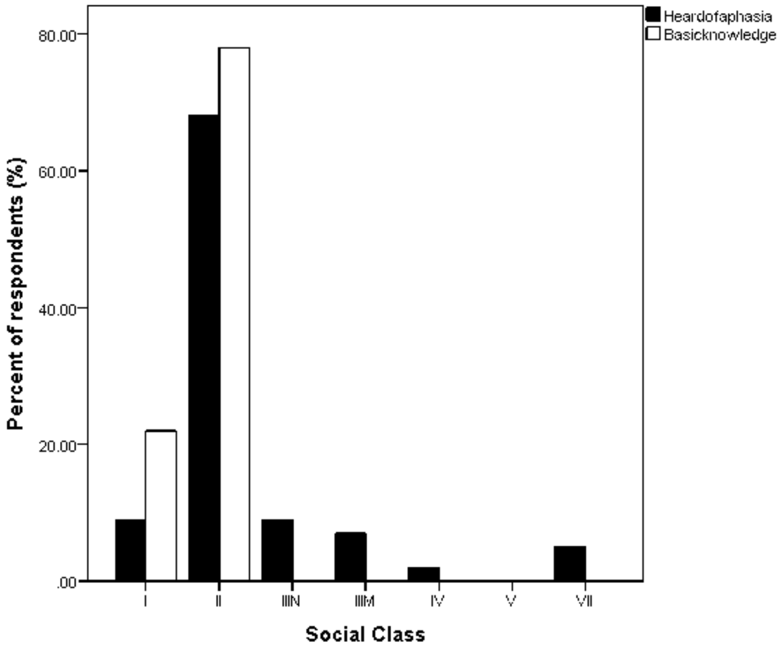


Figure 2. Heard of aphasia and basic knowledge broken down by social class.

# Discussion

While basic knowledge of aphasia would appear to be lower in 2017 than in 2001 in Exeter, a higher percentage of respondents said they had heard of aphasia than in 2001. The lower percentage for basic knowledge is disappointing, but at least a higher percentage reported that they had heard of aphasia. Health care workers were more likely to have some knowledge of aphasia.

We discuss issues arising from these results and consider the limitations of the study.

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# Long-term treatment of lexical retrieval in Primary Progressive Aphasia

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## Introduction

The primary progressive aphasias are clinical presentations of frontotemporal lobar degeneration or Alzheimer's disease characterised by prominent language impairments with relative sparing of other cognitive abilities in the early years post-onset. Three clinical variants of primary progressive aphasia (PPA) recognized in a recent consensus paper (Gorno Tempini et al., 2011) are nonfluent/agrammatic-, semantic- and logopenic-variant PPA, and there are further "mixed" cases that do not meet diagnostic criteria for these variants (Sajjadi, Patterson, Arnold, Watson & Nestor, 2012). Difficulty in word retrieval is typically an early and frustrating symptom (Mesulam, 2001), prompting investigation of lexical retrieval therapy in PPA. A recent critical review (Jokel, Graham, Rochon & Leonard, 2014) concluded that the immediate treatment effects and the maintenance of gains with ongoing practice seen in lexical retrieval therapy are promising. There is, however, a need for better understanding of treatment generalisation and maintenance effects, and of participant and treatment factors producing optimal gains (Cadório, Lousada, Martins, & Figueiredo, 2017; Jokel et al., 2014). The aim of the present study was to investigate item generalisation and effects of treatment duration in an experimental pretest-posttest single case series of individuals with various PPA presentations.

## Methods

### *Participants*

Participants were seven individuals with PPA: two with non-fluent/agrammatic variant, two with logopenic variant, two with semantic variant, and one with mixed PPA, recruited in Sydney, Australia (n = 4) and Munich, Germany (n = 3).

### *Treatment materials and procedures*

The lexical retrieval treatment procedure was "Repetition and Reading in the Presence of the Picture" (Croot et al., 2015) carried out by the participant at home using a personal computer, taking approximately 10 minutes per day on 5 days per week.

Treatment materials were approximately 120 personally-relevant words chosen in consulation with the participant (and close communication partner where possible), with an equal number of words selected for treatment from two broad topics relevant to each participant, such as “family life” and “hobbies and interests”. Items from one topic chosen at random were divided into two sets of approximately 30 items each, matched on spoken frequency, length in syllables and phonemes, and naming accuracy on the first two baselines sessions, and balanced for number of items belonging to semantic sub-categories within the broad topic (e.g. there would be an equivalent number of items related to reading and literature versus outdoor sports in each set within the “hobbies and interests” topic). Words were predominantly picturable nouns, with some proper nouns, adjectives and verbs also selected for treatment. Two pictures illustrating each word were sourced from the internet: one was presented during the picture naming assessments pre- and post-treatment, and the other in the treatment materials.

The study was conducted in five phases: baseline/pretest (Phase A), treatment of one randomly-chosen set of matched items for two weeks (Phase B), posttest (Phase C), treatment of the other set of matched items for four weeks (Phase D), and finally, treatment of all items (both topics) continually for 26 weeks (Phase E). One participant continued practising for almost 2 years at her request. Naming accuracy was not probed repeatedly throughout each phase, as naming assessment per se can yield improved naming (Nickels, 2002) which would confound effects of Repetition and Reading in the Presence of the Picture. Internal validity was addressed with opportunity for three demonstrations of the immediate treatment effect per participant, three data points in the baseline phase per participant, practitioner blinding to item treatment status, and assessor blinding to item treatment status and phase of the study. All aspects of external validity described on the 15-item Risk of Bias in N-of-1 Trials (RoBiNT) Scale (Tate et al., 2013) were addressed as recommended.

### *Analysis*

Analysis is currently in progress, using Weighted Statistics (WEST; Howard, Best, & Nickels, 2015). We will investigate the overall trend in number of correct responses across the study period, and compare the three baseline/pretest measures with the posttest measures for treated versus untreated items following 2 weeks, 4 weeks, and 26 or more weeks of treatment, for each participant.

## Results

Two participants were unable to continue in the study beyond Phase C due to rapid decline in health and cognitive function. The other five participants completed Phase D. Three of these five also completed Phase E; another two who completed Phase D did not adhere to treatment during Phase E. Plots of naming accuracy for all partipants suggest that treated items improved while untreated items did not, thus we replicated the immediate treatment effects that have been previously reported (Jokel et al., 2014). Increasing treatment duration from two weeks to four weeks did not appear to increase the treatment effect in any striking way, but analyses are still in progress. Visual inspection of the naming accuracy plots also suggests that participants who adhered to treatment until the end of Phase E showed gains in naming accuracy at the end of the study compared to their baseline more than six months previously, whereas participants who carried out 2 to 4 weeks’ treatment and then ceased treatment activities lost their gains over the following months.

# Discussion

Statistical analysis is ongoing, but visual inspection of data across participants suggests that individuals with PPA who sustained home practice using Repetition and Reading in the Presence of a Picture over an extended period (more than 6 months in two cases, and 2 years in another) made gains in picture naming and maintained them. Participants who practised for 2 or 4 weeks made gains but lost them over one to six months. Neither of these outcomes were restricted to a single PPA variant. Despite the treatment of multiple items within semantic categories, and the inclusion of semantically-related items of similar difficulty in the untreated set, there was no support for generalization of treatment effects to untreated items using Repetition and Reading in the Presence of a Picture.

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# The influence of treatment intensity on anomia therapy outcomes in chronic post-stroke aphasia.

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## Introduction

There is conflicting evidence regarding the role of treatment intensity on therapy outcomes for anomia in adults with aphasia. Despite a trend in the literature and a number of clinical guidelines recommending intensive aphasia therapy, evidence for high intensity treatment is often based on studies where high intensity schedules also delivered a higher dosage or total amount of therapy compared to low intensity conditions, meaning that it is unclear whether intensity or dosage is responsible. A small number of dosage-controlled studies suggest that distributed therapy may result in equivalent or even superior naming gains. Aphasia Language Impairment and Functioning Therapy (Aphasia LIFT) is a comprehensive aphasia program (see Dignam et al., 2016). We conducted a dosage-controlled trial of Aphasia LIFT delivered in an intensive versus distributed schedule and investigated the effect of treatment intensity on treated and untreated items and connected speech.

## Methods

34 adults with chronic, post-stroke aphasia participated in the study. Previous reports from this cohort focused on language battery outcomes (Dignam et al., 2015) and the relationship between treatment outcomes and learning capacity (Dignam et al., 2016) while the present study examined the influence of intensity on treated and untreated items and connected speech. A baseline language assessment was administered, which included an evaluation of participants' receptive and expressive language skills (Comprehensive Aphasia Test) and 3 baseline naming probes to identify sets of treated and untreated items (matched for baseline naming accuracy, frequency, name agreement, and number of syllables). Based on participants' baseline language performance, individuals were classified as having a deficit in semantic or phonological processing, or in mapping semantics to phonology. Participants were allocated to an intensive (n = 16; LIFT 16 h per week, 3 weeks) versus distributed (n = 18; D-LIFT 6 h per week, 8 weeks) treatment condition. Therapy primarily targeted word retrieval and included 48 hours of impairment, functional, computer and group-based training. Word-retrieval deficits were treated using an approach based on phonological components analysis and semantic feature analysis (Boyle & Coelho, 1995; Van Hees et al., 2013; Wambaugh, 2003). Computer therapy also targeted word-retrieval and was delivered by StepbyStep and Aphasia Scripts. Functional therapy was tailored to individuals' communication goals and included script training and communication partner training.

The cumulative treatment intensity for impairment-based therapy (i.e., total number of therapy exposures for the duration of treatment) was measured for each participant. Naming of treated and untreated items was assessed immediately post-therapy and at 1 month follow-up. To further examine generalisation, connected speech samples were elicited at baseline, immediately post-treatment, and 1 month follow-up. Connected speech samples have been analysed on a subset of the LIFT (n=3) and D-LIFT (n=3) cohorts using the Computerised Language Analysis program.

# Results

Both groups made significant improvements in naming of treated items at post-therapy (LIFT $p < .001$; D-LIFT $p < .001$) and at 1 month follow-up (LIFT $p < .001$; D-LIFT $p < .001$). Furthermore, there was a significant increase in naming untreated items at post-therapy (LIFT $p = .001$; D-LIFT $p < .001$) and 1 month follow-up (LIFT $p = .001$; D-LIFT $p = .001$). At the individual level, participants with semantic processing deficits demonstrated the most variable response to treatment. Qualitatively, a greater proportion of D-LIFT versus LIFT participants maintained treatment gains and achieved generalisation to untreated items. Aphasia severity was significantly correlated with therapy outcomes for the LIFT group only (post-therapy $p < .001$; 1 month follow-up $p = .005$). For the connected speech analysis, comparison between matched pairs of participants receiving LIFT versus D-LIFT revealed no difference between the two treatment schedules across all outcome categories: verbal productivity, grammatical complexity and information content. Comparison within individuals for connected speech measures showed significant effect sizes for D-LIFT participants only. Further improvements in connected speech were also noted for some D-LIFT participants at follow-up.

# Discussion

Intensive and distributed models of Aphasia LIFT resulted in improved naming for treated and untreated items at post-therapy and 1 month follow-up. Therapy gains were comparable across groups and importantly a distributed treatment model did not reduce the efficacy of Aphasia LIFT. Participants' age, TPO and cumulative treatment intensity did not influence therapy outcomes. At the individual level there was a trend favouring D-LIFT with respect to the maintenance and generalisation of treatment gains. Further research with a larger cohort of participants is required. Despite trends in the literature advocating for intensive treatment, this research provides evidence that both intensive and distributed therapy can be efficacious in the remediation of anomia. These findings have important clinical implications for service delivery models in aphasia rehabilitation.

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# The contribution of corpus callosum to lateralization of the resting state language network

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## Introduction

Language production and comprehension rely on a largely distributed network of brain areas mostly of the left hemisphere (Bishop, 2013). However, such left-lateralized functional asymmetry for language has been found altered in some healthy (e.g., left-handers) and various clinical (people with autism, brain tumors, trauma or stroke) populations (Crosson et al., 2009; Knaus et al., 2010; Tantillo et al., 2016). Recent findings (Josse et al., 2008; Hinckly, 2016) revealed the critical contribution of the corpus callosum (CC) size to language lateralization: counterintuitively, as CC size increased, stronger left lateralization was found, suggesting the inhibitory role of the CC in interhemispheric interactions. We tested this hypothesis measuring lateralization of resting state language networks and the CC size in healthy people and stroke patients with aphasia.

## Methods

### *Participants*

Thirty-two left-hemisphere stroke patients with aphasia (9 females; age = 56 ± 10 years; median post-stroke onset = 8 months) and 32 age-matched healthy volunteers (22 females; age = 51 ± 10 years) with no record of neurological or psychiatric disorders participated in the study. All participants were right-handed, monolingual Russian speakers, without premorbid speech or language impairment. Patients were recruited at the Center for Speech Pathology and Neurorehabilitation (Moscow, Russia), where their neuropsychological status was assessed by a certified clinical neuropsychologist. All patients had aphasia diagnosed in terms of A.R. Luria's classification (Luria, 1962/1966) and included non-fluent (efferent motor, afferent motor, dynamic) and fluent (sensory, acoustic-mnestic, semantic) types of aphasia of the whole range of severity scored using the Quantitative Assessment of Speech in Aphasia (Tsvetkova, Akhutina, & Pylaeva, 1981).

### *MRI data acquisition*

The MRI data were obtained at a 1.5T Siemens Magnetom Avanto scanner. High-resolution 3-D structural images were acquired using a T1-weighted MPRAGE sequence (TR/TE/FA=1.9s/2.93ms/15°; spatial resolution 1x1x1 mm; matrix 256x256; 176 slices). Resting-state fMRI whole-brain volumes were acquired with T2*-weighted BOLD imaging (TR/TE/FA = 3s/50ms/90°; spatial resolution 3.9x3.9x3.75 mm; matrix 64x64; 35 slices; 180 volumes). Participants were instructed to stay awake in the scanner, with their eyes closed; no active task was given.

### *Data analyses*

Data preprocessing was performed in SPM8. Following the procedure recommended by Allen et al. (2011), we identified resting state networks using group independent component analysis in GIFT. As a result, in a joint cohort of 64 participants, 29 networks were revealed, including language, default mode, frontal executive, attentional, higher visual and visual functional networks, all classified on the topographical basis. We used univariate tests corrected for multiple comparisons over all networks to test the difference between people with and without aphasia in the intensity of resting-state spatial maps, related to the connectivity and degree of co-activation within a network (Allen et al., 2011). The effect of group was only found significant in one language network involving the superior and middle temporal gyri, the inferior frontal gyrus and the basal ganglia bilaterally. To establish the direction of the group effect, using SPM8 we compared the intensity of activation between people with aphasia and healthy individuals in binary masks of the two (left and right) components of the found language network. The size of each participant's CC was measured using normalized T1 images. Average white matter volumes of the CC were extracted based on the atlas by Mori et al. (2008).

## Results

The left part of the revealed language network (specifically, left superior temporal gyrus, see Fig. 1 left) displayed stronger intensity of spontaneous activity in healthy individuals than in people with aphasia, while the right part of the network (right superior temporal gyrus and basal ganglia, see Fig. 1 right) was more strongly activated in people with aphasia. This difference in lateralization was not affected by the aphasia type, nor by severity.

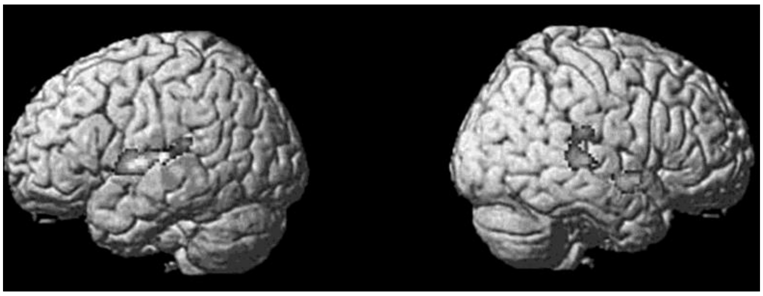

Fig. 1. Components of the resting state language network with stronger intensity of spontaneous activity in healthy individuals (left) than in people with aphasia (right).

Overall, the CC volume was found reduced in patients as compared to healthy individuals ($p < .001$). Critically, in a joint group of patients and healthy people, significant positive correlation ($r = .34$, $p < .01$) was found between the CC volume and the left-lateralized intensity in the language network. In turn, the correlation between the CC volume and the right-lateralized intensity was found negative ($r = - .26$, $p < .05$).

## Discussion

A clear asymmetry has been found between healthy individuals and brain-damaged people with aphasia, regarding the revealed resting state language network. The left-lateralized component of this network was stronger in healthy people, in contrast to its right components, which was more strongly recruited in people with aphasia. More intense engagement of the right hemisphere language-related homologues under the condition of a left-hemisphere damage was suggested underling this asymmetry (Saur, 2006). However, we found a significant contribution of the CC size to the language network asymmetry. As the size of the CC increased, the left lateralization of the network increased. With decrease of the CC size, in contrast, the right lateralization increased. Overall, the CC was smaller in patients with aphasia, which explains their altered left-hemisphere asymmetry for language. This is the first evidence from the resting state functional data regarding language lateralization in people with aphasia and it structural determinants.

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# Motor Evoked Potentials of upper-limbs predict aphasia recovery.

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## Introduction

Communication disorders occur in one-third of stroke patients[1], and the amount of recovery impacts on their quality of life[2]. Several studies identified age, gender, handedness, lesion size, lesion location, stroke subtype, aphasia/stroke initial severity as prognostic factors for recovery from aphasia[3-8] see also the review by Watila M.M. and al.[9]). However, prediction of recovery still remains difficult to establish initially for patients with initial severe aphasia[9]. For the most severe cases, other factors also could contribute to enrich the prognosis of post-stroke recovery, factors related to initial language assessment and speech performance. Some authors reported that an initial composite phonological performance (involving production tasks: repetition and reading aloud) or repetition score seems to be better predictord than initial severity of aphasia[4, 10]. Motor speech planning are among the common processes involved in repetition and reading tasks, which can thus be related to the speech motor networks. Here we investigate whether the electrophysiological evaluation of the Motor Evoked Potentials (MEPs) stimulating the corticomotor pathway using Transcranial Magnetic Stimulation (TMS) could improve the prediction of post stroke aphasia recovery. MEPs seem to be a good predictor of motor recovery[11-14]. This approach could also be used to investigate prediction of aphasia recovery studying a modulation of the cortical excitability of motor areas. Indeed, it has been shown that speech processes and motor network have to be preserved for the recovery of language[3, 10, 15]. Moreover, a reading aloud task modify the cortical excitability of the motor areas of the upper right limb[16] in healthy subjects, as well as in aphasic patients[17], testifying to a global sensory motor integration in language production tasks. Motor network explored using TMS seems to be involved in language, in production tasks but also in comprehension tasks[18, 19], particularly concerning the lips and the upper limb[17, 20]. In addition, some authors showed that treatment outcome of aphasia is enhanced by electrical stimulation of the motor cortex[15], testifying the involvement of motor components in recovery from aphasia.

In the present study we aimed to determine whether the integration of an electrophysiological measure of the motor networks using MEP in the acute phase of stroke can improve the prediction of recovery from post-stroke aphasia.

# Methods

Fifty-seven patients with aphasia within 14days after stroke completed the 6months post-stroke study. Inclusion criteria were to be French-speaking, right-handed, with a first left hemispheric stroke confirmed on imaging. Exclusion criteria were impairment of consciousness or coma, illiteracy, dementia, severe dysarthria, psychiatric history, major visual or hearing disorder, pregnancy, and contraindication to TMS

The severity of aphasia was determined by the Aphasia Severity Rating Scale (ASRS)[21, 22], as a measure of functional verbal communication at baseline (as soon as possible within the first 14days post-stroke) and 6months (M6) post stroke. All patients received conventional speech and language therapy until the last assessment.

Other clinical, sociodemographic and anamnestic data which could influence recovery[9] were collected during hospitalisation, i.e. sex, age, educational level, NIHSS[23].

TMS was used to assess the functional integrity of the ipsilesional and contralesional corticomotor pathway, as soon as possible between one and 14days after stroke symptom onset (baseline). MEPs were recorded from the abductor pollicis brevis muscle (APB) using standard surface EMG techniques. APB mapping and resting motor threshold (rMT) evaluation were assessed by using standard protocols[24]. rMT was defined for each muscle and a rMT ratio (rMTr) was calculated for upper limbs and for lips, with the following formula: $\frac{left\ rMT - right\ rMT}{left\ rMT + right\ rMT}$.

We screened the association between usual predictors of aphasia recovery and the severity of aphasia at each time point and the changes in severity of aphasia. Then, we ran multivariate regression analyses including only the significant predictors from the univariate analyses (i.e. initial severity) an rMTr, in a two-level model with the ASRS at M6 or the changes of ASRS between baseline and M6 as the dependent variables to analyse rMTr contribution (change of $R^2$) when added in the second level. A p-value<0.05 was considered statistically significant.

# Results

Thirty-two men and twenty-five women were included (mean age= 65.69, SD=14.9). A highest aphasia severity initially predicted a worth outcome at M6 (Beta=0.690, t=7.003, p<0.001) and less changes of severity (Beta=-0.556, t=-4.913, p<0.001) while the rMTr shifted toward the left only predicted better outcome of aphasia at M6 (Beta=0.638, t=-6.095, p<0.001). But conversely, including only patients with severe aphasia initially, for whom the change analysis is relevant, rMTr was correlated with the outcome and the severity changes (respectively Beta=0.617, t=4.829, p<0.001and Beta=0.494, t=3.501, p=0.001) while initial severity was only correlated with severity at M6 (Beta=0.639, t=5.115, p<0.001). Adding the rMTr to initial severity permitted to improve the predictive model of the severity at M6 ($R^2$=0.628, F(2,53)=44.726, p<0.001; $R^2$ change: F(1,53)=21.656, p<0.001) as well as the severity changes ($R^2$=0.491, F(2,53)=27.513, p<0.001; $R^2$ change: F(1,53)=21.656, p<0.001). Including only patients with severe aphasia initially (n=41), a same improvement was noted for the severity at M6 ($R^2$=0.513, F(2,37)=21.533, p<0.001; $R^2$ change: F(1,37)=10.420, p=0.003) and for the severity changes ($R^2$=0.206, F(2,37)=6.052, p=0.005; $R^2$ change: F(1,37)=10.420, p=0.003).

# Discussion

The main results highlighted MEPs of upper limbs are strong determinants of the prediction of post-stroke aphasia recovery, particularly for patients with severe aphasia initially. Added with usual clinical factors, MEPs of upper limbs could explain as much change of the variance in language performances or aphasia recovery as other classical variables studied. Moreover, for patients with severe aphasia initially, those who can improve in a longitudinal follow-up, MEPs' analyses seem to be a relevant predictor of aphasia recovery. To our knowledge, no studies have investigated MEP in the prediction of aphasia recovery, but only in the prediction of motor recovery[12]. These findings claim in favour of the inclusion of an electrophysiological approach also to predict aphasia recovery. MEPs analyses reflect cortical excitability and left and right motor recruitment, confirming that a higher right recruitment is associated with poorer recovery. This is in line with the idea that larger shift toward the right hemisphere testify against efficient mechanisms of neuroplasticity (see review of Anglade et al. 2014[25]).

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# Verb and Sentence Test in Russian: a showcase of two people with fluent aphasia

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## Introduction

Difficulties with verbs are among the most common manifestations of aphasia. They can be present at both production and comprehension levels irrespective of aphasia type (e.g., Bastiaanse et al., 2003). Nevertheless, a tool for comprehensive assessment of verb deficits in Russian is presently unavailable.

In our study, we present a partial adaptation of the Verb and Sentence Test (VAST; Bastiaanse et al., 2000; 2003; 2015) to Russian. The original VAST consists of production and comprehension subtests that are based upon a detailed neurolinguistic model of sentence processing (Levelt, 1989; Bastiaanse et al., 2006). This abstract presents preliminary results of the adaptation of the comprehension subtests. We describe the five subtests in Russian and demonstrate that our newly adapted test allows to discriminate between two fluent patients that are expected to perform differently according to Luria's (1970) view on aphasia syndromes.

## Methods

### *Materials and Procedure*

The Non-Verbal Association task assesses the ability to process action concepts in a picture-to-picture matching task. The participants are presented with a target picture and have to choose the most closely semantically related picture from three alternatives.

The Verb Comprehension task assesses the comprehension in a word-to-picture matching task. The verb is presented orally along with four pictures: the target, a semantically related distractor, and two distractors with the objects related to the depicted actions.

The Sentence Comprehension task assesses comprehension of reversible sentences in a sentence-to-picture matching task. Two pairs of semantically reversible actions with the same actors are presented orally: the target, a distractor with the thematic roles reversed, and two semantic distractors with direct and reversed roles.

The Plausibility Judgment subtest estimates the ability of morpho-syntactic parsing of semantically irreversible sentences. A grammatical sentence with either semantically plausible (half of the cases) or implausible role assignment was orally presented, and the participant has to say whether the sentence sounds normal or weird.

As Russian is a language with rich morphology and relatively free word order, the Russian version of the VAST had to be modified accordingly. For example, the morpho-syntactic parsing relies upon the processing of noun inflections which are sometimes closely phonologcally related. Hence, a Minimal Pairs task was added to assess vowel discrimination at the end of the word. Pairs of two-syllabic nonwords are orally presented. The participant has to judge if they were same (half or the cases) or different.

The number of items in each test is given in Table 1. All the subtests are presented via the AutoRAT app (Ivanova et al., 2016) on a tablet.

## *Participants*

Nine non-brain-damaged speakers (NBDs), all native speakers of Russian, completed all the comprehension subtests. There were six females, mean age was 53 years (*SD* = 5, *range* = 46–58), and the mean level of education was 14 years (*SD* = 2.73, *range* = 10–18).
The two patients had left-hemisphere stroke-related chronic aphasia. They were recruited at the Center for Speech Pathology and Neurorehabilitation (Moscow) where they were administered a standard neuropsychological and a language assessment. Both patients suffered from fluent aphasia: patient 1 was a 68 year-old male (education = 15 years) with mild-to-moderate acoustic-mnestic aphasia (comparable to anomic aphasia); patient 2 was a 68 year-old female (education = 10 years) with severe-to-moderate sensory aphasia (comparable to Wernicke's aphasia).

# Results

Patient 1 performed outside the normal range on all tasks except for Minimal Pairs and Plausibility Judgment. His errors in Sentence Comprehension were mainly choosing semantic distractors with direct thematic roles. In Verb Comprehension, he chose object pictures related to target actions.
Patient 2 performed outside the normal range on all tasks except for Non-Verbal Association. In Sentence Comprehension, she chose the target and reversed distractor picture equally frequently (*N* = 16). The results are presented in Table 1.
Table 1. *The percentages correct of the patients and NBDs; scores outside of the normal range are in bold*

| **Subtest (N of items)** | **Patient 1** | **Patient 2** | **NBDs, median** | **NBDs, range** |
|---|---|---|---|---|
| Minimal Pairs (28) | 100 | **7.14** | 100 | 96.43-100 |
| Non-Verbal Association (20) | **75** | 95 | 90 | 85-100 |
| Verb Comprehension (40) | **92.5** | **92.5** | 100 | 95-100 |
| Sentence Comprehension (40) | **87.5** | **40** | 97.5 | 95-100 |
| Plausibility Judgment (60) | 100 | **49.15** | 100 | 91.67-100 |

# Discussion

The two patients demonstrated different patterns of verb impairment at the comprehension level. In Patient 1, poor results on the non-verbal association and semantic errors on the sentence comprehension were accompanied by ceiling performance in the Plausibility Judgment subtest. The choice of related objects in verb comprehension might indicate partial processing of semantic information. This suggests a purely semantic nature of the deficit. In patient 2, the choice of the reversed and not the semantically related pictures in the Sentence Comprehension subtest demonstrates an impairment to assignment of thematic roles. The deficit of the morpho-syntactic processing is confirmed by at-chance level performance in the Plausibility Judgment subtest. However, this deficit might be related to the inability to process noun inflections at the phonological level, as demonstrated by poor results in the Minimal Pairs subtest.
Acoustic-mnestic aphasia is characterized by instability of auditory images of words which can lead to the alienation of word meaning. Sensory aphasia is characterized by impaired comprehension based on the primary impairment of phonemic perception (Akhutina, 2016; Luria, 1970). Both our patients complied with this view, at the same time extending the notion of the syndromes into the domain of verb and sentence processing.
Overall, we were able to contrast the verb and sentence comprehension deficits in two people with fluent aphasia by revealing their different neurolinguistic basis. The current study is ongoing and will be expanded by adding the production subtests and by collecting data from people with other aphasia types.

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# Number and Gender Agreement in Saudi Arabic Agrammatism

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## Introduction

Agrammatism has raised questions about the underlying representations and processes that account for impaired language structures. Cross-linguistic data informed by linguistic and processing theories has yielded conceptual frameworks on causes of impairments in aphasia. One of the unique cases to consider is the case of Arabic agrammatism. Arabic language is a Semitic root language that displays a complex interfaced morphological system. The base unit of projection is the root which is the consonant skeleton: a stem without the vowels or prosodic pattern. A stem is projected by mapping unto phonological and morphological patterns. As such, the morphology of nouns is complex and highly overt inflectional and interdependent on multi licensing rules (McCarthy and Prince, 1990; Pierce, 1992). The case of agreement in the determiner phrase (DP) in spoken Saudi Arabic has not been investigated in agrammatism. Such data may reveal new information that could inform theoretical models. One of the models set out to account for the underlying processes of agrammatism is the parallel access model (Caramazza, 1997). Unlike the two-stage model (Levelt, 1989) which claims that the syntactic information (lemma) is in a level between the semantic representation and the lexical phonology, the parallel access model argues for a parallel access to the syntactic representations and lexical phonology. In other words, the syntactic information and the lexical-phonological information are at the same level but there is a dissociation of syntactic information from lexical-phonological information. Such model would predict that a person with agrammatism may be able to produce the stem noun (N) and adjective (Adj) without agreement inflections when triggered because he does not have complete access to word-specific syntactic information such as grammatical gender and/or number. This study reports data on one case which is part of a research project that investigates DP structures in Arabic agrammatism. The aim of this study is to map and interpret elicited production data on DP gender and number agreement within the parallel model framework.

## Methods

### *Participant*

A forty-year-old male right-handed Saudi Arabic monolingual speaker (TA) with agrammatism participated voluntarily in the study. The participant was 44 months post onset. A diagnosis of Broca's aphasia was retrieved from the medical records and consulted with the attending neurologist and speech-language pathologist. The participant had sensory abilities within functional limits according to the neurologist, speech pathologist and medical records. The data collection took place in the outpatient clinic at a medical clinic in KSA between January and March 2016. Consent to participate was obtained from the patient. Patient's confidentiality was protected. All study protocol followed the code of ethics of the hospital. The study received approval by the internal review board of the Departmental Research Ethics Committee in the Department of Human Communication Sciences at the University of Sheffield prior to data collection.

## *Procedure*

TA responded to an elicitation experiment involving NP production with number and gender agreement. The stimuli were on Saudi Arabic DP, and the structures were masculine singular (*N-M.SG + Adj-M.SG), feminine singular (N-F.SG + Adj-F.SG), masculine plural (N-M.PL + Adj.M.PL) and feminine plural (N-F.PL + Adj-F.PL)*. The test included nine training items and 24 test items. There were six test items in each of the masculine singular, feminine singular, masculine plural and feminine plural category. After a training trial, the examiner started by presenting a picture depicting one person or an object with certain characteristics and after providing the singular noun and adjective (e.g. *rasam wasʕiχ* 'dirty male painter'), she instructed TA to look at and name the second picture, which depicted either the other gender (e.g. *rasam-ah wasʕiχ-ah 'dirty female painter')* or a plural (e.g. *rasam-in wasʕiχ-in 'dirty male painters)*. Data was transcribed, coded and analysed using descriptive statistics.

# Results

As depicted in Table 1, TA showed error patterns with mismatch between the target outcome DP (NP-AdjP) and his output. The participant tended to substitute feminine singular with masculine singular, masculine plural with masculine singular, masculine singular with feminine singular and feminine plural with feminine singular.

Table 1.

*TA types of inflectional errors in both noun and adjective across four categories*

| Target Category (n=6 per each) | Substitution with M SG | Substitution with F SG | Substitution with M PL | Substitution with F PL | Correct |
|---|---|---|---|---|---|
| **M SG (N-M.SG)** | | 1 | | | 83.3% (5) |
| **M SG (Adj-M.SG)** | | 3 | | | 50% (3) |
| **F SG (N-F.SG)** | 3 | | | | 50% (3) |
| **F SG (Adj-F.SG)** | 5 | | | | 16.7% (1) |
| **M PL (N-M.PL)** | 3 | | | | 50% (3) |
| **M PL (Adj.M.PL)** | 4 | | | | 33.3% (2) |
| **F PL (N-F.PL)** | 1 | 2 | 1 | | 33.3% (2) |
| **F PL (Adj-F.PL)** | | 4 | 1 | | 16.7% (1) |
| ***Total*** | ***16*** | ***10*** | ***2*** | ***0*** | ***41.7% (20)*** |

# Discussion

In the current study, TA tended to name the N and Adj correctly and substitute number and gender inflections in the N and Adj. TA's ability to access the lexical phonology was highly preserved but access to the syntactic information was impaired. This mismatch was predicted by the parallel access model (Caramazza, 1997). TA's error patterns revealed a dissociation of syntactic information from lexical-phonological information. TA was able to access the lexical-phonology but he did not to access the syntactic information.

However, TA's access to the syntactic information was not completely blocked. To illustrate, TA accessed a partial match for the feminine singular indicated by the feminine inflection produced for *F PL* targets. TA accessed grammatical gender information in Arabic but not the grammatical number information. If the syntactic information was completely dissociated, TA would not access the feminine suffix as it is a marked morpho-syntactic feature. The Arabic DP agrammatic data revealed that syntactic dissociation in the parallel access model could be partial. Theoretical implications for underlying representations in agrammatism and Arabic linguistic theory are provided.

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# The Gulf-Arabic Aphasia Screen

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## Introduction

In Gulf-Arab countries, speech and language therapy (SLT) is a developing field, with a lack of assessment and therapy materials available in native languages. For example, the Arabic language was listed as the fourth spoken language all over the world, yet only 5 aphasia related articles were published in regard of the Arabic-speaking population in 2 011(Beveridge & Bak, 2011). To assess the language proficiency of people with aphasia (PWA) therapists are still reliant on informal assessments and/or translated western-language assessments which are not sensitive to the linguistic and cultural feature of the Arabic language. This may lead to inaccurate diagnosis (Khamis-Dakwar & Froud, 2012). There is progress developing a cross culturally adapted version of a western-language assessment (The Comprehension Aphasia Test) for Egyptian colloquial populations (Abou El-Ella et al., 2013). However, due to the diversity of Arabic dialects, using Egyptian-Arabic speaking population materials for Gulf-Arabic speaking populations is problematic (Beveridge & Bak, 2011). The aims of this project were to begin development of an Arabic aphasia assessment test for Gulf-Arabic speaking populations and to conduct a preliminary evaluation of the test's performance with healthy adults and PWA.

## Methods

### *Material*

Development for the Gulf-Arabic Aphasia Screen (GAAS) began with the collection of self-developed informal assessments that were being used by a group of experienced Saudi SLTs, based on their clinical experience with PWA and existing western aphasia language assessments. Those assessments were collected and modified by the first author and sent to a focus group of experienced Saudi SLTs to be reviewed and re-modified. Subtests for the GAAS were also developed to match existing Aphasia assessments from western language assessments, in order to cover key modalities of spoken and written language (speech, auditory comprehension, reading, writing) and different language tasks (repetition, naming, picture description etc.). All task materials were carefully chosen to be culturally and linguistically appropriate for Gulf-Arabic speaking population. A talented Saudi female painter drew the pictures for the test, with special attention to preparing culturally relevant pictures.

The GAAS consists of 14 subtests. The final version of the assessment includes the following:

- Complex Picture description: describe a pictured scene using sentences.
- Auditory comprehension of single nouns and verbs: spoken word to picture matching (four pictures).
- Auditory comprehension: simple and complex commands. Perform a set of commands that vary in complexity (e.g. Hold your fingers, hold your fingers then point to the door then close your eyes).
- Auditory comprehension: answering yes/no questions.
- Repetition: repeating words and sentences.
- Single word picture naming: name pictures that include nouns and verbs from different categories.

- Spoken sentence completion: participants will be asked to complete a given sentence using one word only.
- Spoken categorical naming (fluency): participants will be asked to generate words from a given category.
- Spoken responsive naming: participants will be asked to answer a set of questions using one word only
- Spoken automated sequence: participant will be asked to count from 1 to 20, and recite a part of 'holy Qur'an'
- Auditory to written stimuli: single letter and single written word recognition
- Reading comprehension of sentences: participants will be asked to read sentences out loud and chose the appropriate answer from a set of four given sentences (similar to multiple choice questions).
- Written comprehension of single words: match a word to a picture (four pictures).
- Writing on demand: asked to write their full name.

### *Participants*

Norming: a total of 32 healthy Gulf-Arabic adult age ranged from 81 to 71 years old (9 male and 23 female), all without known communication problems, all participants spoke Arabic as their first language.

Participants with aphasia: 14 participants with Aphasia age ranged from 34 to 68 years old (10 males and 4 females), all with Left MCA stroke.

## Results

Initial norming was carried out on healthy normal adult to pick up problematic items or subtests (e.g. unclear task instructions, unclear pictures, difficulties with sentences). We found that during the complex picture description task healthy adults produced few words with an average number of 13.34 words per minutes; however healthy adult in Western literature produce an average of 29.77 words per minutes when describing the cookie theft (a complex picture description task from Boston Diagnostic Aphasia Examination BDAE) (Ardila & Rosselli, 1996).

Following modification of the subtest, 14 participants with aphasia completed the GAAS. All were tested in hospitals in Gulf Arabic countries, administered by the first author and other trained SLTs. The test took approximately 30-35 minutes to be completed. This data is currently being analysed to provide an over-view of performance (range, comparison against norms) and aphasia classifications based on results. This will include data on how long the test takes to complete for PWA, and modifications to instructions or administration that have resulted from this pilot testing.

## Discussion

Performing the GAAS on healthy adults provided an overview of the suitability of the test material, stimuli and tasks. We found that healthy adult speakers produced short and simple sentences during complex picture description. This has implications for how the PWA data should be scored and analyzed. As expected, materials specific for Gulf-Arabic speakers had to be developed and included (e.g. picture stimuli, linguistic stimuli). Preliminary data from PWA demonstrates that the test is feasible for use in a clinical setting. Further data analysis is planned to demonstrate test-retest reliability and inter-rater reliability. The GAAS will be made freely available following publication of pilot data, including normative data, guidance on scoring and administration.

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# Mass reference and its encoding into language. A preliminary study in aphasia.

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## Introduction

Traditional grammar descriptions trace a division between mass and count nouns on the base of some lexical and morphosyntactic properties. Mass nouns (*sand*) mostly refer to substances, do not occur in the plural, especially after quantifiers, and cannot be modified by indeterminate articles. Conversely, count nouns (*mug*) mostly denote objects, can be inflected in the plural and modified by indeterminate articles.
Theoretical linguistic accounts describe mass nouns as formally simpler than count nouns (Borer, 2005; Chierchia, 2010; Krifka, 1995), yet experimental literature does not provide consistent evidence in this sense. Some lexical decision studies reported longer response times associated to the processing of mass nouns (Gillon et al., 1999; Mondini et al., 2009), whereas some others did not find any difference (Mondini et al., 2008; Franzon et al., 2016). A preference for countability is reported in studies on acquisition (Barner & Snedeker, 2005; Gathercole, 1985) and in neuropsychological studies (Herbert & Best, 2010; Fieder et al, 2014; 2015). Crucially, count syntax can be overextended to mass nouns even when other grammatical abilities are matured and/or spared, both in children's and patients' performance (Zanini et al., 2016; Semenza et al., 1997).
We preliminarily tested the aphasic performance on countability exploiting a new task to better check the stimuli selection and pursue the exploration of the puzzling mass/count contrast.

## Methods

### *Materials*

A version of the MACT test for children (Zanini et al., 2016) was validated for adults by means of an online grammaticality rating (Zanini et al., 2017). In the MACT, nouns were categorized as mass or counts by measuring their frequency of occurrence in mass and in count morphosyntactic contexts in the it-WaC corpus (Baroni et al., 2009).
The experimental items consisted in: 10 mass nouns, i.e. nouns appearing frequently in mass contexts that are not among the top count-used nouns (*sand*); 10 count nouns, i.e. nouns appearing frequently in count contexts that are not among the top mass-used nouns (*mug*); 20 "neutral" nouns, i.e. nouns that appear with comparable frequency both in mass and count contexts (*cake*). For each noun, two identical sentences were created: in one the noun appeared in a mass context, in another one in a count context, for a total of 80 experimental sentences. Two conditions were incongruent: mass nouns in count context and count nouns in mass context; the other four conditions were congruent. All nouns were presented in the singular.
Participants were asked to listen to the sentences and state whether they were correct or incorrect. Congruent sentences accepted and incongruent sentences rejected were scored 1 point, incongruent sentences accepted and congruent sentences refused were scored 0 points.

### *Participants*

Seven Italian aphasic patients (age: 55-77) with close-to-normal scores on the MMSE participated in the study. Their grammatical abilities were assessed by means of the ENPA and an agreement task involving 132 noun phrases (Franzon et al., 2014).

# Results

Six patients either performed well or failed homogeneously at the MACT, being the mass and count conditions similarly spared or impaired. Yet, significant differences were found in SD's performance (age: 77, education: 5). SD suffered an ischemic stroke with cortical and subcortical involvement in left temporo-parietal areas. His grammatical comprehension of sentences was spared (ENPA score: 14/14) and his production of agreement was only mildly affected by phonological errors.
SD performed significantly worse on mass nouns in count context (3/10) than on count nouns in mass context (9/10; *Crawford and Howell's t-test*: t= -6.241, p= .001), having accepted mass nouns in a count context. He performed at ceiling in all other conditions, including mass nouns in mass context.

| | Congruent conditions | | Incongruent conditions | | Neutral Nouns (congruent) | |
|---|---|---|---|---|---|---|
| Participant | Mass noun, Mass context | Count noun, Count context | Mass noun, Count context | Count noun, Mass context | Neutral noun Mass context | Neutral noun Count context |
| F.C. | 10 | 10 | 10 | 9 | 17 | 19 |
| L.C. | 6 | 10 | 9 | 9 | 11 | 14 |
| **S.D.** | 10 | 10 | 3 | 9 | 20 | 20 |
| D.F. | 9 | 10 | 8 | 9 | 17 | 20 |
| A.F. | 8 | 10 | 10 | 10 | 16 | 16 |
| A.G. | 6 | 6 | 8 | 7 | 11 | 12 |
| R.M. | 10 | 10 | 9 | 10 | 17 | 17 |

# Discussion

These data, collected with improved methods as far as the stimuli selection is concerned, both replicate the pattern reported in Semenza et al. (1997) and match the trend found in preschool children (Zanini et al., 2016) in which count syntax is overextended to mass nouns. A grammatical deficit alone is not sufficient to predict SD's selective impairment as his overall grammatical abilities are otherwise spared. Frequency of occurrence of a noun in mass or count syntactic contexts cannot provide a complete account of such trend as well: if that was the case, SD's performance on count nouns and mass nouns in incongruent conditions would be similar.
These data suggest that the distinction between mass and count expressions is probably spread along a hierarchy of difficulty, where the count reference and the count syntax, may be accepted as the default. It may be also the case that the information about countability contextually encoded into the language is actually independent from the grammar, but related to non-linguistic cognitive abilities underpinning the representation of the referents. Zanini at al. (2016) correlated children's preference for countability to the fact that mass reference is more abstract than the count one. In fact, conceiving a mass entity, whose incidental boundaries can be very variable, may require more logical abilities of abstraction and conservation. In adults, such abilities are fully mastered; nonetheless it could be the case that they require extra cognitive efforts and in turn affect the linguistic encoding of mass reference when no frequency cues come at play.

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# Expressive syntactic abilities and verbal short term memory in children with focal brain lesion

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## Introduction

Recent studies on children with focal brain lesions (FL) have compared their performance to that of typically developing (TD) children to investigate whether rehabilitation in language and cognition is possible and if so to what extent (Balantyne et al. 2008; Marchman et al. 2004). Recent studies reveal controversial findings. On one hand, some findings indicate that children with focal brain lesions (FL) show some degree of neural plasticity (Stiles et al., 2005) and brain reorganization (Staudt, 2010). Therefore, intellectual and language skills may be within the normal range in children suffering perinatal stroke and similar focal brain lesions (Aram and Ekelman, 1986; Riva and Cazzaniga, 1986; Trauner et al., 1993; Ballantyne et al., 1994; Stiles, 1995). In contrast, other findings reveal that recoverability is subject to particular limitations. For example, it has been reported that while children experienced *early* focal brain damage show normal performance on single-word vocabulary and other receptive or expressive language tasks in the future, they do not exhibit a complete recovery when they get older (Ballantyne et al., 2007, 2008).
The present study aims at examining the cognitive and linguistic skills of Greek FL children in comparison to TD children matched on chronological age (CA). Specifically, we address the question of recoverability in linguistic abilities and verbal short term memory (VSTM) abilities of children with FL. We thus investigate whether children who suffered a stroke in infancy or childhood show neural brain plasticity, and if this neural brain plasticity is sufficient to develop expressive syntactic abilities and VSTM abilities at normal levels.

## Methods

### *Participants*

Two groups of subjects participated in the experiments: One experimental group with children with FL, and one control group, a Chronological Age (CA) control group. 16 children who have suffered a stroke in infancy or childhood and 62 children typically developed were tested. The CA of the groups is ranged from 5;10-17;6 years. All the children with FL were recruited from the paediatric department of the Hippokration hospital of Thessaloniki. Further background information on the history of the participants' language difficulties (e.g. dyslexia; dysarthria) was collected from interviews with the parents and the speech and language therapists' case notes. All the typically developing children were recruited from public schools in Greece.

### *Materials and procedure*

In order to investigate the performance of Greek speaking children with FL on VSTM and expressive syntactic abilities we employed the following measures :

1. A short term memory task developed by Talli (2010). For this task, children listened and then repeated one by one a total of 24 non-words (NW) orally presented by the experimenter, varying in length from 3 to 6 syllables. The pseudoword repetition task was used to assess phonological skills, and precision was taken into account.

2. A Wh-question elicited production task based on the methodology developed by Crain and Thortnon (1998). In this task, pictures were employed and the child asked the experimenter a question about them**.** Subject and object *who* and *which-NP* questions were elicited. Six examples for each question type were tested giving a total of 24 responses.
3. A relative clause elicited production task based on the methodology developed by Crain and Thortnon (1998). This task includes a series of pictures that depict animals. Every time, three different pictures were presented. The experimenter asked a question regarding the three pictures, and the participant should choose the correct picture by answering with a relative clause. In total, 18 subject and object relative clauses were elicited. All participants were individually tested on the following measures.

# Results

The children with FL showed substantial impairment relative to controls in NW repetition. Individual data analysis indicated that 6 of these children performed 1.5 SD below the typical mean performance on the NW repetition task while 2 children could not perform the task at all. These two children could not perform the syntactic tasks as well.

With respect to the rest of the children, they performed up to ceiling (100%) with the exception of 3 only children who showed impairment (performance 1.5 SD below typical mean) in the production of object Wh-questions. Notably only one of these children showed performance 1.5 SD below the typical mean on the production of object relative clauses while all other children with FL showed typical performance.

As far as the FL children whose performance was 1.5 SD below the typical mean are concerned, only two children shown parallel impairments in the domain of VSTM, object Wh-questions and object relative clauses. Four children showed selective deficits in the domain of VSTM while one only child showed impaired performance on the production of object Wh-questions.

# Discussion

These results indicate that impairments in VSTM can appear without impairments in complex syntax for some FBL participants. Therefore, VSTM deficits do not necessarily implicate impairment in the domain of expressive syntactic abilities. In addition, despite developmental plasticity, these results suggest that impairments in language and/or cognition may insist over time. Further analysis is currently being performed on these results in relation to the lesion site and size to provide explanations of different individual profiles.

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# Characterization of agrammatism in Akan.

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## Introduction

The spontaneous speech of patients with agrammatic aphasia is characterized by effortful and telegraphic speech production (if any production at all), word retrieval difficulties, phonological distortions, and grammatical errors such as omissions and substitution of free and bound grammatical morphemes, while comprehension is generally good (Bastiaanse & Jonkers, 1998; Menn & Obler, 1990; Rossi & Bastiaanse, 2008, Anjarningsih & Bastiaanse, 2011). Previous findings have observed that agrammatic speakers' use of embedded sentences is limited (Bastiaanse et al., 2002). At the lexical level, studies have shown that individuals with agrammatism produce nouns to a normal extent but fewer verbs and/ or of a lower diversity than normal (Bastiaanse & Jonkers, 1998). Morphologically, verb inflection difficulties have also been observed in agrammatism (Thompson, et al., 1995). Previous studies have found that tense and aspect are susceptible to impairment in individuals with agrammatic aphasia (Dragoy & Bastiaanse, 2013; Stavrakaki & Kouvava, 2003). However, finite and nonfinite verbs referring to the past have been found to be more difficult for Dutch agrammatic speakers to produce than verb forms referring to the present (Bastiaanse, 2008). According to the PAst DIscourse LInking Hypothesis (PADILIH), this difference in tense (past and present) is as a result of discourse linking – that is verb forms referring to the past are more difficult to produce than those that refer to non-past because the past requires discourse linking.
Akan is an SVO language. Unlike Indo-European languages, Akan is a tonal language, and thus, uses grammatical tones to mark tense and aspects (Dolphyne, 1988). The current project addresses the following questions: 1) What are the features of Akan agrammatic speech? Are they comparable to Indo-European languages? 2) What is the agrammatic speakers' pattern of verb production morphology for tense and time reference in Akan? To answer these questions, spontaneous speech analyses will be performed.

## Methods

### *Materials and Design*

The spontaneous speech sample of 5 individuals with aphasia (IWAs) recruited from the Korle Bu Teaching Hospital, Ghana, and 5 non-brain damaged (NBD) speakers of Akan was collected by using a semi-structured interview. Two of the interview questions aimed at eliciting information that refer to the past from patient, and the other two for information that refer to the present. For example:

Reference to the past:
Can you tell me about how your stroke started? *Wobetumi aka biribi afa sɛnea wo stroke no fitii aseɛ*?
Can you tell me about your work before your stroke? *Wobetumi aka biribi afa edwuma a na woyɛ ansa na wobɛyare*?

Reference to the present:
Can you tell me something about your family? *Wobetumi aka biribi afa w'abusua ho*?
Can you tell me about your hobbies*? Wobetumi aka biribi afa nea wo taa yɛ mmere a wonni edwuma yɛ*?

### *Procedure*

The speech samples were recorded on a Mobile-Audio digital recorder, and then transcribed by the experimenter for analysis. A speech sample size of 230 words was taken from each patient for analysis. According to Brookshire and Nicholas (1994), 300 words is a reliable sample size for spontaneous speech for typologically/linguistically isolating languages such as English, Dutch and Italian. Even though Akan is not as agglutinative as languages such as Swahili and Turkish, information like subject pronouns and negation are agglutinated to the verb to form a single word rather than 3 words (which would have been the case in some isolated languages). To characterize an agrammatic speech, the following variables were analyzed: Speech rate (number of words per minutes (wpm)); mean length of utterances (MLU); type token ratio (TTR) for verbs and nouns; percentage grammatical sentences; word order; and past to present time reference ratio. The analysis took a conservative approach, comparing the scores of the IWAs to the range of the NBDs, being either below or above this range.

## Results

The results (see Table 1) indicated that each of the IWAs had slower speech rate (46 – 79 wpm) which fell below the range of their matched NBDs (105 – 153wpm). In addition, the IWAs made more grammatical errors (20% – 49.3% of errors), used fewer embedded sentences (8.4% - 20%), and had a lower mean length of utterance (MLU: 3.26 – 4.35) than the NBDs , hence we classify them as having agrammatic aphasia, based on the criteria of Menn and Obler (1990). The analysis of verb inflection and time reference through grammatical tone and other verb forms shows that the speech of the agrammatic speakers contains fewer past forms relative to the NBDs. All agrammatic patients except one patient (who produced 29.4%) fell below the range of the total number of past forms produced by their matched controls. However, both the agrammatic individuals and the NBDs made more reference to the present than to the past.

Table1. Characteristics of the spontaneous speech sample of the Agrammatic speakers and the NBDs

| **Participants (IWA):** <br> **Speech Characteristics** | DOA | EAF | DOD | MO | FOB | **NBD(range)** |
|---|---|---|---|---|---|---|
| Speech rate (wpm) | 63 | 64 | 58 | 79 | 46 | 108 - 153 |
| MLU | 3.77 | 3.73 | 3.73 | 4.35 | 3.26 | 5.82 – 7.31 |
| TTR-verbs | 0.36 | 0.56 | 0.47 | 0.30 | 0.65 | 0.53 – 0.67 |
| TTR-nouns | 0.68 | 0.78 | 0.67 | 0.59 | 0.75 | 0.58 – 0.85 |
| | **%** | **% %** | **%** | | **%** | **%** |
| Embedding | 10.3 | 20.6 | 15.7 | 8.4 | 12.3 | 30 – 43.7 |
| Grammatical errors | 30.6 | 49.3 | 44.4 | 20 | 45.8 | 0 – 6.4 |
| Non-past (produced) | 84 | 93.9 | 89.1 | 71.6 | 96.6 | 66.7 - 81 |
| Past (produced) | 16 | 6.1 | 10.9 | 29.4 | 3.4 | 19 – 33.3 |

Note: WO = Word order; MLU = Mean Length of Utterance; wpm = word per minute; TTR = Type Token Ratio.

## Discussion

Cross-linguistically, agrammatic speech is characterized by effortful and telegraphic speech production, shorter utterances, lower diversity of produced lexical verbs, word retrieval difficulties, and grammatical errors (Bastiaanse and Jonkers, 1998; Menn & Obler, 1990; Rossi & Bastiaanse, 2008; Anjarningsih & Bastiaanse, 2011). Based on our findings, these features are also characteristics of agrammatic speech in Akan as well. Interestingly, although present and past time reference in Akan is expressed through grammatical tone, the agrammatic speakers produced considerably fewer past forms than the NBDs. This finding is in line with the predictions of the PADILIH, which posits that reference to the past is difficult whether it is expressed through grammatical morphology or tone (Bastiaanse et al., 2011).

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# Aligning sentence structures in a language game: evidence from healthy aging and aphasia

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## Introduction

Speakers align syntactic structures with their conversational partners. Gruberg et al. (in prep-a) discovered that this syntactic alignment occurs for associations between event content and sentence structures, also known as syntactic entrainment, beyond the level of sentence constituent orders. These effects are shown in both young adults and children, and are viewed as reflecting ongoing prediction error-based 'tuning' or language learning throughout the lifespan. Crucially, the prediction errors that cause syntactic alignment are experienced during comprehension, rather than production of sentences (Chang, Dell, & Bock, 2006; Jaeger & Snider, 2013), predicting that listening to their interlocutor's utterances would suffice for speakers to adapt their production preferences. We test this hypothesis in older and aphasic speakers to better understand the mechanisms of syntactic learning. Experiment 1 examined syntactic entrainment in a comprehension-based picture matching game. In Experiment 2, the game was modified so that the participant repeats their partner's utterances during card matching, obligating prior production of the target structures.

## Methods

### *Participants*

Experiment 1 included 20 young, 20 older adults, and 13 adults with aphasia. Experiment 2 is ongoing, and data from 12 older adults and 6 adults with aphasia have been collected so far.

### *Materials and Procedure*

Participants played a collaborative language (picture-matching) game. Participants played the 'matcher' and subsequently 'director' roles with the experimenter, who described pictures using either preferred (active, prepositional dative, and on-variant locatives) or non-preferred structures (passive, double-objective dative, and with-variant locative). In Experiment 1, when playing the matcher role, the participant placed their cards in the correct order after listening to the experimenter's sentences. Then the participant, playing the director role, described pictures for the experimenter to match. In Experiment 2, participants were instructed to verbally repeat the experimenter's sentences before they select the matching picture card, thus obligating prior production of target sentences. Remaining procedures were the same as Experiment 1. In both experiments, we measured whether the participant produced the same structures to refer to specific events in the pictures as the experimenter when they were playing the director role.

# Results

Results for Experiment 1 revealed that young adults were more likely to produce preferred structures upon hearing experimenter's use of preferred vs. non-preferred structures (68% vs. 55% $p < .001$) – that is, syntactic entrainment. However, no syntactic entrainment effects were shown in older and aphasic participants (older: 60 % vs. 56%; aphasic: 57% vs. 59%). In Experiment 2, , in contrast to the findings from Experiment 1, both older (81% vs. 63%; $p < .001$) and aphasic speakers (77% vs. 52%; $p < .05$) produced preferred structures more frequently following experimenter's use of preferred vs. non-preferred structures .

# Discussion

Together, our findings show that comprehension-induced prediction error is not sufficient for successful syntactic entrainment effects in older and aphasic speakers, different from what has been shown in young adults and children (Gruberg et al., in prep a, b). This further suggests that as an effect of aging and aphasia, content-structure mapping becomes stabilized so that active production of target content-structure associations has most predictive effects in syntactic learning. In sum, the current study illustrates that the mechanisms of syntactic learning change as a function of age and modality, which may need to be considered in the existing models of error-based implicit language learning (Chang et al., 2006; Jaeger & Snider, 2013).

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# Online sentence processing in adults and individuals with aphasia

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## Introduction

One key area of interest in aphasiology is differential impairment of nouns and verbs, and differential sensitivity to content and function words. In particular, agrammatism linked to inferior frontal gyrus lesion, is claimed to be associated with verb and function word deficits, while anomia, associated with temporo-parietal damage, is linked to noun impairments. The source of noun-verb differences, however, is unclear (Vigliocco et al., 2011). Our current knowledge on language processing in people with aphasia largely comes from studies which use offline tasks such as the sentence-picture matching (Kay, Lesser & Coltheart, 1996; Thothathiri, Kimberg, & Schwartz, 2012; Varkanitsa et al., 2016) or grammaticality judgment (Wilson & Saygin, 2004). These tasks require participants to make explicit, strategic and reflective judgments (Inglis, 2003). By contrast, online measures of language processing allow measurement of implicit, non-strategic language processing in real-time. Further, online measures enable the evaluation of function word processing, particularly those function words with low semantic content.

In the current study, we examined neurotypical and aphasic language profiles using an online word monitoring task. We explored processing of noun phrase (NP) and verb phrase (VP) structures in three conditions: (1) premodifier priming (bare VP: *John PLAYED*; premodified VP: *John **may have** PLAYED*; bare NP: *saw CATS*; premodified NP: saw ***the thin*** *CATS*), (2) trigram frequency (VP high frequency: *time to TURN* ; VP low frequency: *space to TURN*; NP high frequency: *asked for DIRECTIONS;* NP low frequency: *looked for DIRECTIONS*), (3) NP/VP structure violation (VP: **telling/saying** a JOKE; NP: ***a little/few*** *PERFUME*).

We investigated whether: 1) premodification of NP/ VP structure facilitates recognition of the N/V head; 2) Frequency of three word combinations (trigrams) influences speed of word recognition; 3) Violations to NP/VP structure impedes sentence processing. Further, we were interested in how traditional offline measures correlate with online language measures. Younger and older neurotypical normative patterns were established to examine age-related processing effects.

## Methods

### *Participants*

The study included a group of aphasic participants and two groups of neurotypical adults. The neurotypical younger adult group consisted of 27 participants (19 women, 8 men; mean age=20.6, SD=3.03). The neurotypical older adult group included 20 participants (12 women, 8 men; mean age=64.6, SD=11.52). All participants were native speakers of English with no history of speech/language impairments. Currently, data collection of individuals with aphasia is ongoing. Data from 20 individuals with aphasia will be reported at the conference.

### *Materials and Procedure*

The experiment employed an auditory word monitoring task (WMT) to explore online sentence processing in neurotypical younger and older adults and in individuals with aphasia. In a WMT, participants hear sentences (“John PLAYS guitar”) and press a button on hearing the target word (PLAYS). The task measures reaction time (RT) and accuracy of responses to target words embedded in sentence contexts. Sensitivity to experimental manipulation was determined by normalized RT

difference per sentence pair. Syntactic manipulations were considered facilitatory if RTs to targets were faster in 'expected' conditions compared to 'unexpected' (i.e., no premodification, lower frequency and violation) conditions.
Older adult and individuals with aphasia also completed a battery of offline linguistic and non-linguistic tasks. The linguistic battery included offline sentence comprehension, naming, phonological working memory, and connected speech tasks. Further, non-verbal reasoning was measured through WASI Matrices.

# Results

Violation and facilitation conditions evoked predicted effects on reaction times. The violation condition had the greatest impact on RT. Word recognition was facilitated in higher frequency trigrams and in the presence of premodification of the noun/verb head, but slowed by structure violations. Effect sizes were greater for VP than NP conditions, except for the trigram frequency condition, where participants were more sensitive to frequency differences within NPs.
The most prominent age-related effect was found in the NP structure violation condition, with more marked slowing in the older participant group. This indicated greater re-integration cost as a consequence of the violation in the older group.
Data collection of individuals with aphasia is ongoing and data analysis comparing neurotypical older adults and individuals with aphasia will be included. Further, we will present comparisons between online and offline measures of language processing.

# Discussion

In a first step, we established normative patterns of online processing in neurotypical adults. On the basis of these neurotypical findings, we will profile aphasic participants' performance in VP versus NP processing to identify sensitivity to premodification, frequency and structure.

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# A pilot study on the effects of Parkinson's Disease with and without Mild Cognitive Impairments on vowel articulation in spontaneous speech

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## Introduction

Despite being primarily classified as a movement disorder, non-motor symptom cognitive decline has been increasingly accepted as a key feature of Parkinson's Disease (PD) (Kalia & Lang, 2015). Cognitive impairments such as mild cognitive impairment (MCI) and dementia are prevalent in approximately 30% of individuals with PD (Riedel et al., 2008) and have been found to negatively impact quality of life (Duncan et al., 2014). The clinical features of cognitive decline in PD are heterogeneous but comprise impaired memory and visual-spatial functions as well as attention deficits and executive dysfunctions (Hanagasi et al., 2017). The degree to which (if any) cognitive decline affects motor speech disorders in PD was the objective of the current study.
Up to 90% of the individuals with PD exhibit speech motor disorders referred to as hypokinetic dysarthria. As a result of this speech disorder, the range of voluntary articulatory movements is limited, leading to an articulatory "undershooting" (Forrest et al., 1989). An acoustic and perceptual consequence is centralized vowel articulation (Skodda et al. 2011), i.e. vowel formant frequencies become less distinct, which in turn contributes to reduced intelligibility of speech (Kim et al., 2011). Compared to healthy individuals articulatory control requires more attention in individuals with PD (Ho et al., 2002) and has been found to decline with increasing complexity of the task (Rusz et al., 2013). In contrast to speech tasks like vowel prolongation, reading and repetition, spontaneous speech has high cognitive and linguistic demands (Rosen et al., 2005). The attention capacity devoted to the cognitive load is at the expense of the articulatory precision, making spontaneous speech a useful task to acoustically detect vowel articulation abnormalities in PD (Rusz et al., 2013). Since attentional capacities are further reduced by cognitive impairments, we hypothesize that individuals with both PD and additional cognitive impairments are even more compromised in their articulatory precision during spontaneous speech than individuals with PD only.
We report on the outcome of a pilot study on the influence of MCI in individuals with PD on vowel articulation precision in spontaneous speech using phonetic approaches.

## Methods

### *Participants*

Three groups of German native speakers were included in this study. The first group (PD group) consisted of five individuals with idiopathic Parkinson's Disease (*mean* age = 80.2, *sd* = 3.5). None of these speakers exhibited signs of cognitive impairments (MMSE *mean* = 28.8, *sd* = 1.1). The second group (MCI group) comprised four individuals (*mean* age= 81.5, *sd* = 1.8) with idiopathic PD and additional mild cognitive impairments (MMSE *mean* = 24, *sd* = 2.3). The third group served as healthy control (HC group) and included five age-matched subjects without neurodegenerative diseases (*mean* age = 74.6, *sd* = 6.5).

### *Design*

Monologues were elicited through an open-ended question on a familiar topic. Responses were audio recorded for an average of seven minutes (*sd* = 3.7) each. Recordings were made with a Zoom H2 Recorder with a 16-bit quantization and a sampling frequency of 44.1 kHz. The recordings were conducted in an identical manner for all participants.
For each monologue, the point vowels /a/, /i/ and /u/ were extracted when the following selection criteria were met: the vowel occurred in an intelligible word, the duration of its stable part (one period after onset and one period before the offset of the vowel) was at least 40 ms and the vowel was free of co-articulation.

### *Phonetic Analysis*

Praat (Boersma, 2001) scripts were run to determine the first (F1) and second (F2) formant frequencies (in Hz) of the stable part of each selected vowel. The F1 and F2 were averaged separately per vowel and speaker. The vowel articulation measurements such as vowel space area (VSA), vowel articulation index (VAI) and F2 ratio of the /i/ and /u/ were constructed from these averages. Typically a low VSA, ratio and VAI indicate a reduced range of articulatory movements and thus represent imprecise vowel articulation (Sapir et al., 2010).

## Results

Descriptive statistics of the participants' vowel measurements show the predicted pattern of articulatory precision for each speaker group reflected by the acoustic vowel measurements (see Figure 1). The MCI group yielded lower values for all metrics (VSA: *mean* = 42740, *sd* = 19217; ratio: *mean* = 1.35, *sd* = 0.12; VAI: *mean* = 0.72, *sd* = 0.04) compared to the PD group (VSA: *mean* = 60710 , *sd* = 76967; ratio*: mean* = 1.43, *sd* = 0.46; VAI: *mean* = 0.74, *sd* = 0.09). The HC group exhibited the highest values for each measurement (VSA: *mean* = 105100, *sd* = 63348; ratio: *mean* = 1.76, *sd* = 0.42; VAI: *mean* = 0.86, *sd* = 0.09).
We conducted Kruskal-Wallis tests for non-parametrical data to compare each vowel measurement between the groups. A significant difference was found between the measurements of VAI of the HC and the MCI group ($H(2) = 6.17$, $p < .05$). None of the other comparisons yielded significant results, likely due to the limited sample size.

## Discussion

Overall the preliminary results support our hypothesis that individuals with PD and additional MCI manifest more severe vowel articulation imprecision than individuals with PD only. We suspect that the high cognitive load associated with spontaneous speech compromises articulatory precision in hypokinetic dysarthria with MCI. The observed trend supports the sensitivity of spontaneous speech as a task to assess speech disorders.
Yet, further research with a larger sample of individuals with PD, with and without MCI, will be needed to investigate the effect of cognitive decline in PD on vowel articulation in spontaneous speech.

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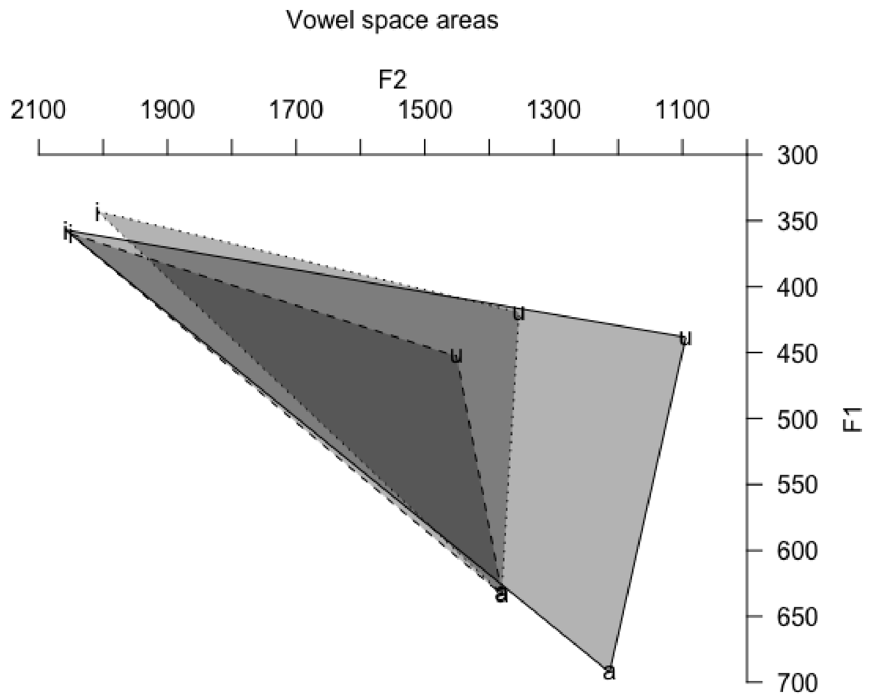


Figure 1: Vowel space areas of the PD group (dotted line), the MCI group (dashed line) and the HC group (solid line)

# Effects of regiolects on the perception of developmental foreign accent syndrome

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## Introduction

Foreign accent syndrome (FAS) is a rare motor speech disorder in which the pronunciation of a speaker is perceived as foreign by listeners of the same language community. Verhoeven and Mariën (2010) distinguished three possible causes of FAS: (1) a variety of neurological etiologies, including developmental disorders (neurogenic (developmental FAS) (2) cases in which a psychogenic cause is suspected (psychogenic FAS); (3) a combined variant with a neurogenic origin in which the change of accent exerts such a significant effect on the psychological status of the patient that he intends to more distinctly appropriate it to develop a more credible personality (mixed FAS). In 2009 two cases of developmental FAS (dFAS) were described in whom the disorder was detected in an early stage of speech-language development. In this study we describe two more cases of dFAS.

## Methods

### *Case descriptions*

Speech samples of two monolingual Flemish-speaking children with FAS qualities were recorded. At the time of language testing case 1 was a six years and four months old right-handed monolingual boy. Medical history was unremarkable. Language development was discordant for his age but assessment of the Dutch CELF-IV (Kort, Schittekatte, & Compaan, 2008) did not confirm the presence of a primary developmental language disorder. The test administrator did not observe a foreign accent at first, but while relistening to the video of the first session, he judged the accent as French. Motor speech planning was disrupted as well. Neurological and otorhinolaryngological investigations showed no abnormalities.

Case 2 is a 14-year-old right-handed boy who was referred because of learning difficulties and attentional problems. Medical history was unremarkable. His speech was nonfluent and marked by severe word finding difficulties, frequent repetitions, interruptions and false starts. The test administrator judged the accent as German. Multidisciplinary assessment confirmed a diagnosis of developmental apraxia of speech and developmental coordination disorder (DCD). An attentional deficit disorder was formally ruled out.

### *Listening panel*

Two panels consisting of 30 native speakers of two regiolects, Dutch and Flemish, evaluated spontaneous speech samples of the two boys with suspected dFAS, three native Flemish-speaking children diagnosed with developmental apraxia of speech (DAS), two bilingual children (L1=Flemish, L2=French or English), and six native Flemish-speaking children with typical speech-language development.

# Results

As shown in Table 1, the entire listeners panel (both Flemish and Dutch judges) identified the two children with developmental FAS as the ones sounding most foreign. All other groups differed significantly from each other, which confirms our hypothesis that children with FAS are perceived as sounding more foreign than children with DAS. Children with DAS are perceived to sound more foreign than bilingual children. Bilinguals on their turn are perceived to sound more foreign than typically developing (TD) children.

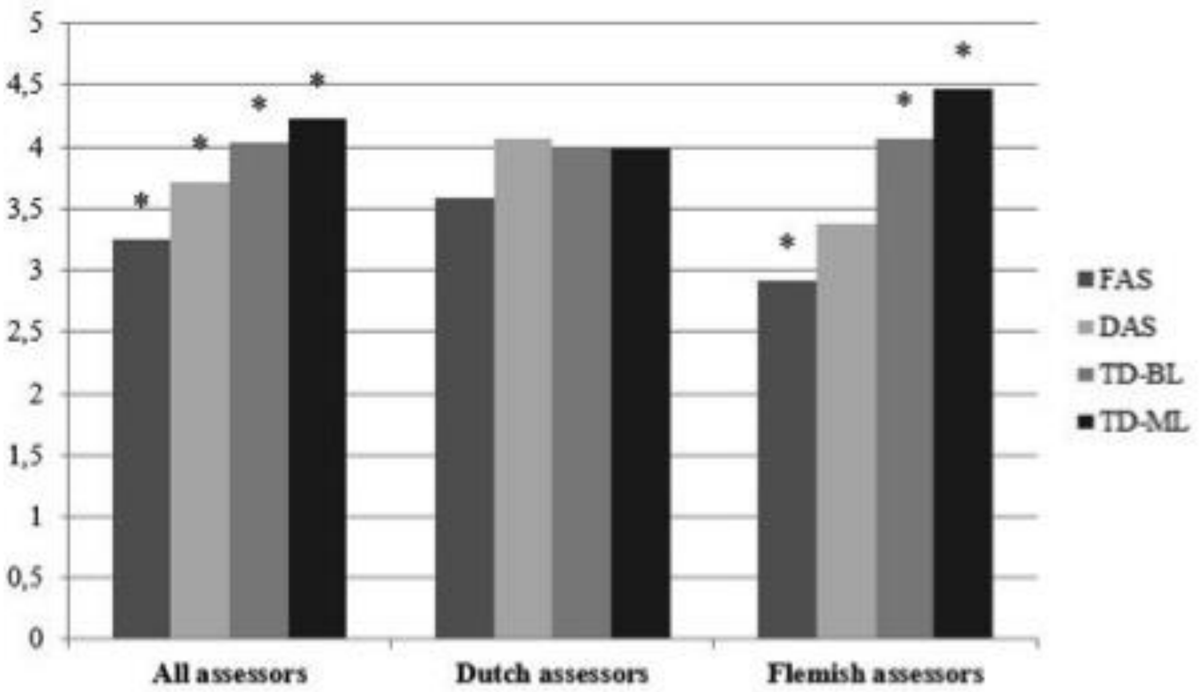


***Figure 1.*** Average rank score per linguistic category for all assessors collectively and for the Dutch and Flemish assessors separately. Asterisks (*) indicate a significant discrepancy ($p < 0.05$). FAS = foreign accent syndrome; DAS = developmental apraxia of speech; TD-BL = typically developing bilingual (Flemish and French); TD-ML= typically developing monolingual (Flemish).

However, focussing at the results of the different regiolect panels, the results differ significantly. The Flemish panel still perceived the accent of the children with FAS as sounding the most foreign of all groups and different from DAS, BL and TD but the difference between the FAS and the DAS group did not reach significance. As for the Dutch respondents, FAS was again the group sounding the most foreign but not significantly different from the other groups. Only minor differences were found between the separate groups of children in the judgments of the Dutch assessors. In contrast to the Flemish assessors, the Dutch judges were not able to distinguish the discrepancies in speech between the different groups of children with another regional variant than their mother tongue. Flemish assessors did not perceive differences in the speech quality of FAS children and DAS children.

# Discussion

The findings of this study support the assumption that FAS and DAS not only share similar semiological and perceptual characteristics but also a common pathophysiological substrate. Although it is not always identified by listeners of the same language community but by speakers of the same regiolect, in addition to FAS resulting from brain damage or a psychological disorder, developmental FAS appears a distinct form of apraxia of speech resulting from developmental deficits.

Surprisingly, the Flemish panel attributed significantly lower scores to the bilingual children in comparison to the TD children, clearly distinguishing them from children with normal speech and language development. This was against our expectation that both groups would not differ significantly because these children received a simultaneous and balanced bilingual education. A possible explanation is that bilingual children present with subtle segmental or suprasegmental features of the second language when speaking Flemish.

The design of the present study is novel in the approach to FAS. Two groups of different regiolects (with a shared mother tongue) were selected as separate listening panels. This allowed us for the first time to examine the perceptual impact of the regiolects of the judges on FAS. Native speakers were hitherto only viewed as a single and homogeneous group of assessors and regiolects have never been taken into account. Regional variance seemed to have a significant influence on the judgment. Future research is needed to expand this notion with the regional variants of other languages.

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# Reliance on common word combinations correlates with degree of syntactic impairment in aphasia

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## Introduction

One characteristic of aphasic language is an increased reliance on formulaic language, i.e. word combinations that are (mostly) lexically retrieved rather than grammatically assembled (Van Lancker Sidtis & Postman, 2006; Wray, 2012). To date there have been only few systematic investigations of formulaic language in aphasia, and the relationship between formulaicity and other aspects of cognition, verbal or non-verbal, remains unclear.

One of the properties that indicates formulaicity is frequency of use, as common word combinations are more likely lexicalized. We developed the Frequency in Language Analysis Tool (FLAT), a computerized analysis which determines the degree of formulaicity in a language sample by extracting words, bigrams and trigrams and determining frequency and collocation measures using the British National Corpus (BNC XML Edition, 2007). FLAT measures can distinguish people with Alzheimer's disease from controls and are related to estimated time post-symptom onset (Zimmerer, Wibrow, & Varley, 2016).

We used the FLAT to compare formulaicity between speakers with aphasia and controls, and investigated the relationship between degree of formulaic production and a range of standardized measures that assess word comprehension and production, sentence comprehension, non-verbal semantic processing, non-verbal reasoning and non-verbal executive function. To account for an individual's repetition of words and word combinations, we conducted analyses on both language tokens and types.

## Methods

### Participants

We recruited 21 participants with a range of type and severity of aphasic impairment and 30 healthy controls. One aphasic participant was excluded because of suspected comorbid dementia.

### Procedure and analysis

Each participant described a wordless cartoon ("Dinner Party") and was assessed using the Boston Naming Test (BNT), the spoken word comprehension subtest of the Comprehensive Aphasia Battery (CAT), the Test of Reception of Grammar (TROG-2), Pyramids and Palm Trees (pictures; PPT), the Matrix Reasoning test from the Wechsler Abbreviated Scale of Intelligence (WASI Matrices), and the Brixton Spatial Anticipation Test (Brixton) as a measure of executive function.

Cartoon narratives were transcribed and formatted for FLAT analysis. We calculated frequency for words, bigrams and trigrams, and t-scores (a measure of collocation strength) for bigrams and trigrams as well as the proportion of words and n-grams that occur in the British National Corpus (i.e. have a frequency higher than zero). We also determined type-token-ratio for words, bigrams and trigrams.

## Results

In both token and type analyses, participants with aphasia produced more word combinations which occur in the British National Corpus. Effects were similar for tokens and types, albeit larger in token

analyses. Participants with aphasia had a lower TTR for words and word combinations, indicating less lexical and combinatorial diversity in production.
In the aphasic group, the ratio of combinations which appear in the British National Corpus correlated negatively with TROG-2 scores. There was a positive correlation between TROG-2 scores and TTR. Other scores did not correlate significantly with formulaicity.

# Discussion

The observation that aphasic output is more formulaic was supported by an automatic, corpus-based analysis. Aphasic participants used more common word combinations. Comparison of language tokens vs. types suggested that the effect is only partially due to increased repetition in the aphasic group, and mostly the result of impoverished linguistic knowledge in aphasia. The impairment appears gradual: As syntactic capacities decrease, so does combinatorial diversity, while reliance on common word combinations increases.
Results are in line with usage-based frameworks which assume that common word combinations are more lexicalized (Croft, 2007; Goldberg, 2006). The same models postulate a “lexicon-syntax continuum” instead of the binary distinction between morphemes and rules. We suggest that, with increasing severity of syntactic impairment, processing at the syntactic end of the continuum becomes unavailable, leaving speakers with (partially) lexicalized constructions.

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