# Predicting verbal fluency performance from executive functions test: A study in healthy subjects

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## Introduction

### Background

- EFs are impaired in several neurologic and psychiatric diseases which is reflected in the speech of the patients (e.g. in Parkinson´s, Schizophrenia)
- Verbal fluency (VF) tasks are part of several neuropsychological diagnostic batteries for assessing executive functions (EFs)
- The relationship between EFs and VF was already investigated by several studies [1,2] but it is still unclear which subdomains of EFs impact VF performance [3]
- Inter-individual differences influence both EFs and VF performance

### Aim

- To examine whether EF performance can predict VF
- To investigate which EF tests and variables impact the prediction analysis of VF the most

## Methods

### Subjects

- n = 235
  - Females: 60%
  - Males: 40%
- Age range = 20-55 (mean age: 35,3)
- Language = Monolingual German
- No neurological / psychiatric diseases

### Analyses

- Data is adjusted for sex and age by linear regression
- Relevance Vector Machine (RVM)
- 10-fold-cross-validation
- 500 replications

### Testing material

Executive function battery

Cognitive flexibility / planning
- Trail Making Test
- Raven´s Standard Progressive Matrices
- Wisconsin Card Sorting Test
- Tower of London
- Cued Task Switching

Working memory / attention
- N-back non-verbal
- Non-verbal Learning Test
- Corsi Block Tapping Test
- WAF-G
- WAF-R

Inhibition
- Stop-signal Task
- Simon Task
- Stroop

Semantic verbal fluency tests
- Based on *Regensburger Wortflüssigkeitstest* [4]
- 2 minutes per test
  - Test1: Animals
  - Test2: Jobs
  - Test3: Switching: Sports / Fruits
- Variable of interest: Total number of correct responses across the three subtasks
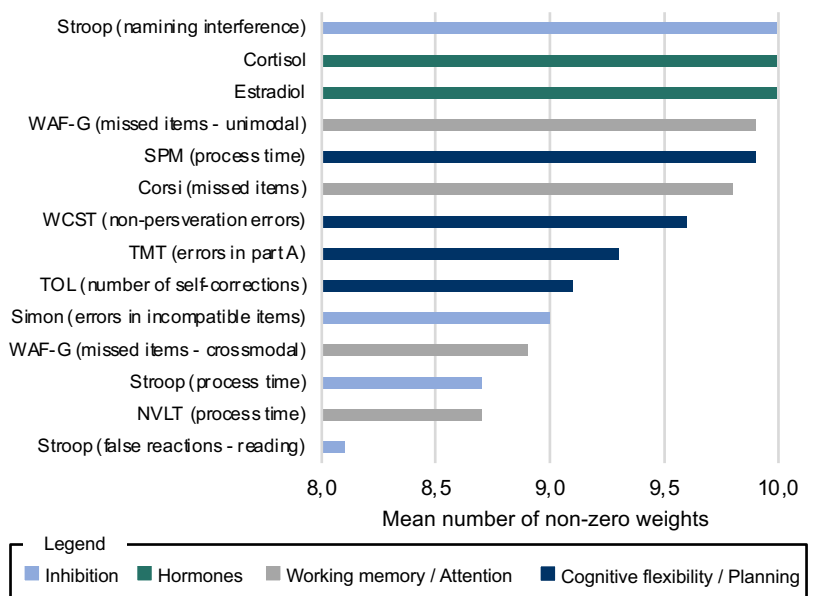
## Results

### Prediction of verbal performance by EFs performance



### Features with strongest impact on prediction analysis
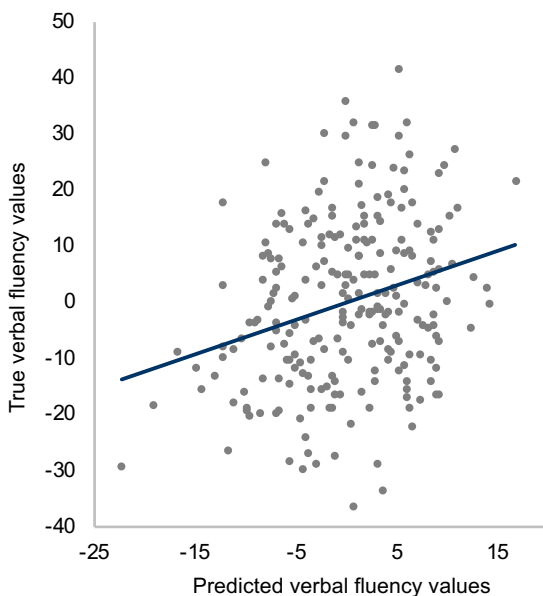


True and predicted verbal fluency scores correlate with r=0.25 highly significantly

Variables of EFs tests tap in all sub-domains of EFs instead of highlighting one specific domain

Stroop test and WAF-G (divided attention) reveal multiple variables for prediction analysis

## Discussion

- We found that verbal fluency performance can be predicted from executive functions scores
- Replicating previous findings, our data show the involvement of cognitive flexibility [5], working memory [6] and inhibition [7] in VF tasks
- Particularly, the Stroop test provide several variables, indicating that this inhibition test and VF might be closely related to each other
- Interestingly, predicting variables go beyond standard variables of tests and also include aspects of processing time and amount of errors – Similarly, a different study showed that poorer executive control leads to slower lexical access [5]
- Stress and sex hormones are predictors for VF performance. Studies found that the level of sex hormones can influence VF performance [8]
- This study provides insights into the detailed relationship between EFs and VF for later on examining whether speech production could predict EFs. Reaching this final goal further speech variables are required to build a powerful model

[1] Fisk, J. & Sharp, C. (2004). *Journal of Clinical and Experimental Neuropsychology*. 26(7):874-890
[2] Azuma, T. (2004). *Neuropsychology*. 18(1):69-77.
[3] Shao et al. (2014). *Frontiers in Psychology*. 5(772):1-10.
[4] Aschenbrenner, S et al. (2001). Regensburger Wortflüssigkeitstest. Göttingen: Hogrefe.
[5] De Paula, J et al. (2015). *Dementia & Neuropsychology*. 9(3):258-264.
[6] Rosen, V. & Engle, R. (1997). *Journal of Experimental Psychology: General*. 126(3):211-27.
[7] Unsworth et al. (2011). *Q J Exp Psychol*. 63(3):447-466.
[8] Griksiene, R. & Ruksenas, O. (2011). *Psychoneuroendocrinology*. 36(8):1239-1248.