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Spoken discourse and memory deficits in English speakers with chronic stroke

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Cognition and Discourse

	Stroke	Dementia	Traumatic Brain Injury (TBI)	Non-brain impaired (NBI)
Executive functions	Associated with poorer **organization** and **informativeness** (Rogalski et al., 2010)	Associated with reduced **organization** (Kim et al., 2021)	Associated with reduced **discourse length** and **informativeness** (Hill et al., 2018)	/
Visuospatial skills	Associated with reduced **global coherence** (Rogalski et al., 2010)	/	Associated with reduced **global coherence** (Kong et al., 2020)	/
Attention	Associated with poorer **global coherence** (Kong et al., 2020; Rogalski et al., 2010; Seixas-Lima et al., 2020; Wright et al., 2014)			
Memory	No correlation between **short-term memory** (STM) and **macro**-structures (Rogalski et al., 2010) **Working memory** (WM) deficits correlated with **coherence** (Cahana-Amitay & Jenkins, 2018)	**STM** and **WM** deficits correlated with impaired **micro**-structures only (Almor et al., 1999; Johnson et al., 2003)	**STM** and **WM** deficits correlated with impaired **macro- and micro-** structures (Hill et al., 2018)	**STM** and **EM** correlated with **global coherence** (Johnson et al., 2003; Wright et al., 2014)

Discourse Macro-structures & Memory

Post-stroke: **WM** correlated with **global and local** coherence → episodic buffer deficits may impede information organisation (Cahana-Amitay & Jenkins, 2018)

Contrast →

Post-stroke: **WM** only correlated with **global** coherence (Rogalski et al., 2010)

Possible reason →

More **extensive WM measurements** may be needed to evaluate its association with local coherence

Post-stroke: **STM** did not correlate with global or local coherence (Rogalski et al., 2010)

Contrast →

TBI and NBI: STM correlated with **coherence** → plan relevant lexical information (Hill et al., 2018; Johnson et al., 2003)

Possible reason →

Limitation in using **MMSE** (Rogalski et al., 2010) → insufficient measurement of STM in post-stroke populations

NBI: **Episodic memory** (EM) correlated with global **coherence** → better EM may enhance the preservation of information (Wright et al., 2014)

Research gap →

EM's role in discourse has not been systematically researched in post-stroke populations

Discourse Micro-structures & Memory

Post-stroke: No correlation between **WM** and **grammatical complexity** and lexical diversity (Cahana-Amitay & Jenkins, 2018)

Contrast →

TBI: Stronger **WM** and **STM** correlated with increased **informativeness** and **grammatical complexity** with decreased **error** frequency (Hill et al., 2018)

Research gap →

Despite **comparable microstructural deficiencies** in post-stroke individuals, research on its association with STM and WM is limited (Alyahya et al., 2020; Thompson et al., 1998)

Aims and Hypothesis

Aims: To examine the relationship between memory and discourse macro- and micro- structures

Specific Research Questions	Hypothesis
Is EM, STM and WM related to global and local coherence?	All memory types will positively correlate with global and local coherence (Cahana-Amitay & Jenkins, 2018; Hill et al., 2018)
If, and how, are STM and WM related to informativeness, syntactic complexity and error frequency?	Stronger STM and WM will correlate with increased informativeness and syntactic complexity with reduced error frequency (Hill et al., 2018)
Which discourse measurements may best predict each memory type?	Global coherence and informativeness may best predict memory in post-stroke speakers (Obermeyer et al., 2021)

Method

Participants

- Data from an ongoing study conducted at The University of Oxford examining post-stroke impacts in 103 native English speakers in the United Kingdom (Demeyere et al., 2021)
- Current **inclusion criteria**: a) minimum 2 years post-stroke, b) completion of all study's data
- **98 participants** met the inclusion criteria

Language samples and Measurements of memory

- **Language samples:** Personal retell (stroke story, important event) and cookie theft picture description → orthographically transcribed → segmented into T-units → language analysis
- **Language analysis measures:** 1) global and local coherence rating, 2) main concept analysis, 3) syntactic complexity, 4) error analysis
- **Memory measures:** 1) STM → OCS, MoCA, WMS, picture memory test, 2) WM → digit span, 3) EM → EM rating scale

Statistical analysis

- Spearman rank correlations → explore the relationship between memory and macro- and micro-linguistic measurements
- Stepwise multiple regressions → explore the power of discourse measurements in predicting each memory type

Results & Discussion: Memory & language

1) Episodic memory

a) EM positively correlated with **global coherence** (stroke story: $\rho=.354^{**}$, $p<.005$; important event: $\rho=0.567^{**}$, $p<.001$; cookie theft $\rho=0.429^{**}$; $p<.004$)
   - Consistent with existing NBI and dementia research → stronger EM may enhance information recall and subsequently increase narrative maintenance (Seixas-Lima et al., 2020; Wright et al., 2014)

2) Short-term memory

a) STM did not correlate with **global coherence** (OCS delayed recall: $\rho=.139$, $p<.289$; OCS recognition test: $\rho=.015$, $p<.912$; MoCA: $\rho=.009$, $p<.943$; WMS immediate recall: $\rho=.113$, $p<.392$; WMS delayed recall: $\rho=.131$, $p<.324$; Picture scene recall: $\rho=.088$, $p<.505$)
   - Inconsistent with existing post-stroke research → current participants had relatively high language and cognitive abilities, results may align better with NBI (Wright et al., 2014) rather than post-stroke studies (Cahana-Amitay & Jenkins, 2018)

b) STM positively correlated with **local coherence** (MoCA: $\rho=.270^{*}$, $p<.037$?; WMS immediate recall: $\rho=.226^{*}$, $p<.031$; WMS delayed recall: $\rho=.234^{*}$, $p.025<$; Picture scene recall: $\rho=213^{*}$, $p<.040$)
   - Consistent with existing TBI research → STM may play a role in shifting between information (Hill et al., 2018)

c) STM positively correlated with **syntactic complexity** (WMS immediate recall: $\rho=.249^{*}$, $p<.017$; WMS delayed recall: $\rho=.217^{*}$, $p<.037$)
   - Consistent with existing TBI research → retrieval of stored syntactic information may facilitate complex sentence production (Hill et al., 2018; Takashima et al., 2020)

d) STM negatively correlated with **semantic error** (Picture scene recall: $\rho=-.210^{*}$, $p<.044$)
   - Only occurred in picture scene recall task (96% semantic errors) → only task that enabled cross-checking

e) STM positively correlated with **syntactic error** (OCS delayed recall: $\rho=.214^{*}$, $p<.039$)
   - Unexpected, inconsistent with all existing research → only occurred with OCS verbal memory subtest

f) STM positively correlated with **informativeness** (MoCA: $\rho=.219^{*}$, $p<.035$?; MoCA: $\rho=.358^{**}$, $p<.001$; WMS immediate recall: $\rho=.373^{**}$, $p<.001$; WMS immediate recall: $\rho=.211^{*}$, $p<.044$; WMS delayed recall: $\rho=.248^{*}$, $p.017$?; WMS delayed recall: $\rho=.229^{*}$, $p<.028$)
   - Consistent with existing TBI research → less efficient in retrieving information from memory stores (Hill et al., 2018)

Results & Discussion: Memory & language

3) Working memory

a) WM did not correlate with **global coherence** (Digit span forward total: $\rho=.055$, $p<.674$; Digit span backward total: $\rho=-.042$, $p<.749$; Digit span forward length: $\rho=.104$, $p<.430$; Digit span backward length: $\rho=.044$, $p<.740$)
   - Inconsistent with existing post-stroke research → possibly impacted by current participants relatively high WM and global coherence scores, results align better with NBI participants (Cahana-Amitay & Jenkins, 2018; Wright et al., 2014)

b) WM positively correlated with **local coherence** (Digit span forward total: $\rho=.220^{*}$, $p<.034$; Digit span forward length: $\rho=.218^{*}$, $p<.036$)
   - Consistent with existing post-stroke and TBI research → episodic buffer deficits may impede information organization (Cahana-Amitay & Jenkins, 2018; Hill et al., 2018)

c) WM positively correlated with **syntactic complexity** (Digit span forward total: $\rho=.248^{*}$, $p<.017$; Digit span forward length: $\rho=.242^{*}$, $p<.019$)
   - Consistent with existing TBI research → indicates WM's role in manipulating information to form complex sentences (Hill et al., 2018)

d) WM did not correlate with **semantic error** (Digit span forward total: $\rho=.133$, $p<.312$; Digit span backward total: $\rho=.169$, $p<.196$; Digit span forward length: $\rho=.113$, $p<.391$; Digit span backward length: $\rho=.209$, $p<.109$)
   - Differing neural correlates → no associations between prefrontal cortex (main WM region) and semantic errors (Cloutman et al., 2009; Kharitonova et al., 2015)

e) WM negatively correlated with **syntactic errors** (Digit span backward total: $\rho=-.214^{*}$, $p<.039$; Digit span backward length: $\rho=.224^{*}$, $p<.031$)
   - Consistent with existing TBI research → suggests WM's role in retrieving and modifying information to be accurately inserted into discourse (Hill et al., 2018)

f) WM positively correlated with **informativeness** (Digit span backward total: $\rho=.252^{*}$, $p<.015$)
   - Consistent with existing TBI research → indicate WM's role in monitoring speech output to prevent irrelevant information (Hill et al., 2018)

Results & Discussion: Discourse predictors

Episodic memory

- **Global coherence** and **semantic error** significantly predicted EM [$F(1,36)=12.375$, $p=.001$, $R^2=.256$]
  - Global coherence → better topic maintenance with more substantive information may indicate higher EM as one can fully recall their experience
  - Semantic errors → activation of middle temporal gyrus (region associated with EM) when producing semantic errors (Rugg & Vilberg, 2013; Walker et al., 2011)

Short-term memory [$F(1, 36)=11.237$, $p=.002$, $R^2=.238$]

- **Global coherence, local coherence** and **semantic errors** significantly predicted STM
  - Global coherence and local coherence → indicates STM's role in linking and shifting between information (Hill et al., 2018)
  - Semantic errors → activation of frontal cortex (region associated with STM) when producing semantic errors (Walker et al., 2011)

Working memory [$F(1, 26)=4.479$, $p=.041$, $R^2=.111$]

- **Syntactic complexity** significantly predicted WM
  - Syntactic complexity → indicates WM's role in holding and manipulating information to formulate complex utterances (Hill et al., 2018)

Conclusion & Future directions

Conclusion

1. Positive correlation between EM and global coherence
1. Stronger STM and WM correlated with increased local coherence, syntactic complexity and informativeness with reduced error frequency
1. Global coherence and semantic error best predicted EM and STM
1. Syntactic complexity best predicted WM

Future directions

1. Current participants were not assessed for aphasia and were relatively high functioning
   → future research can compare **post-stroke aphasic and NBI participants** to explore how correlational findings differ from the current study
2. Findings demonstrate clinical significance in which **stimulating memory during discourse training** may enhance **macro- and/or micro-linguistic** elements of spoken discourse in post-stroke participants (Obermeyer et al., 2021)
   → future research is needed to verify these hypothesized treatment benefits

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