Is working memory resource depletion effect measurable with a domain-specific or with a domain-general working memory test?

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Introduction

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• What is getting depleted? Due to what mechanisms? How is this depletion recovered? How long does it take?
• Our aim: Investigating the working memory resource depletion effect by considering the Time-Based Resources Sharing model (Barrouillet & Camos, 2015)
The Time-Based Resources Sharing model

- Attention is the main resource in WM
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- We have shown its compatibility with cognitive load theory (Puma & Tricot, 2019)
- We have shown that the load predicted by the TBRS model was well observed
  - at the physiological level (Mallat et al., 2019)
  - neurophysiological level (Capa et al., 2013)
  - particularly through the modulations of theta EEG activity (Puma et al. 2017)
Aim

• TBRS model assumes that depleted resource is domain-general
• CLT assumes that academic learning is domain-specific

• In a preliminary experiment, we failed to obtain a resource depletion effect with working memory domain general test (n-back task)

• Now we want to compare domain-general one (n-back task) and a domain-specific one (reading span).
Participants and Materials

• 39 participants
  University students in English language and civilization (year 3 and 4; average 22 y.o.)

• English proficiency
  Oxford Online English: assessment of English level and listening comprehension.

• Reading span task

• N-Back task
  Two blocks of 42 trials with size n = 2.

• Transcription task
  12-minute lecture: Robert Waldinger - "What makes a good life?"

• Motivation and comprehension questions
  6 motivational questions with continuous scale response
  16 true/false comprehension questions (7 literal and 9 inferential)
Procedure

• Independent variables
  • Main task (MT): transcription vs. just listening
  • Working memory task (WT): reading span vs. n-back

• Experimental design
  • $WM_2 \times WT_2$

• Dependant Variable
  • WM post-test minus WM pre-test

• One week before
  • Assessment of English proficiency
  • Assessment of typing speed.
  • Training in reading span or n-back.
Procedure

- RSPAN or n-back
- Listening
- Pause
  - Transcription
  - 2.5 listening time
- RSPAN or n-back
- Comprehension and motivation questions

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Transcription

- 35’ duration divided in 11 segments
- Demand = \(\frac{\text{#letters}}{\text{Time}}\)
- Performances are (very) sensible to demand
Correlations

Demand
• Untranscribed words, $r = 0.75$
• Misprints, $r=0.73$
• Grammatical errors, $r=0.63$

Untranscribed words
• Re-formulations, $r=0.71$

Misprints
• Grammatical errors, $r=0.61$
N-Back - Performances

<table>
<thead>
<tr>
<th>Transcription</th>
<th>Just listening</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Pre-test</td>
<td>0.781</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.764</td>
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No significant difference
N-Back – Response time

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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Pre-test</td>
<td>591</td>
<td>230</td>
</tr>
<tr>
<td>Post-test</td>
<td>571</td>
<td>235</td>
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No significant difference
Reading Span - Performances

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Prr-test</td>
<td>0.763</td>
<td>0.188</td>
</tr>
<tr>
<td>Post-test</td>
<td>0.779</td>
<td>0.166</td>
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No significant difference
Reading Span - Performances

![Graph showing reading span performances with bars representing score changes across different sizes and parts (Pre-test vs. Post-test).]
Comprehension

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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
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<tr>
<td>N-Back</td>
<td>0.606</td>
<td>0.125</td>
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<tr>
<td>RSPAN</td>
<td>0.699</td>
<td>0.096</td>
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- Significant group effect
- \( F(1,36) = 7.270, p = 0.011 \)
Subjective Fatigue

- Significant group effect
- $F(1,36) = 5.357, p = 0.026$

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<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>N-Back</td>
<td>68.7</td>
<td>20.2</td>
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<tr>
<td>RSPAN</td>
<td>72.3</td>
<td>27.6</td>
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WM test perceived difficulty

<table>
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<td>M</td>
<td>SD</td>
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<tr>
<td>----------------</td>
<td>----------------</td>
</tr>
<tr>
<td>N-Back</td>
<td>32.4</td>
</tr>
<tr>
<td>RSPAN</td>
<td>61.8</td>
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- Group effect
- $F(1,36) = 4.16, p = 0.049$
- Test effect
- $F(1,36) = 6.59, p = 0.015$
Additional experiment

• We tested the effect of optimising the time given to transcribe according to the typing performance of participants.
• Same task, in French
• Participants : 40
  • control group : time given to transcribe not adapted
  • experimental group : time given to transcribe adapted to typing performance
Results

• No effect on average
• Huge effect on variance
Discussion

• We fail to obtain a depletion effect of both domain specific and domain general WM tests

• Demanding condition
  • Lower performance
  • Higher fatigue
  • Higher WM test perceived difficulty

• When a learning task is long and demanding, participants can
  • Decrease their performance, preserving their WM resources
  or
  • Deplete their WM resources