An exploration of the relationships between writing behaviors and text quality using keystroke logging, eye-tracking and text analysis

Andrea Révész, Marije Michel, & MinJin Lee
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The end products of writing tasks have been the object of a considerable amount of research in the areas of second language assessment and second language acquisition.
Little empirical research exists that examines the cognitive processes in which L2 users engage while performing writing tasks in second language testing or classroom settings (Révézsz, 2014).
It has also been underexplored how the processes in which L2 writers engage may relate to the quality of the end products of writing.
The aim of this research was to bring together these two areas of second language testing and learning - research on the L2 writing process and the L2 writing product.
Aims of project

Utilising Task 2 of the IELTS Academic Writing Test

1. Explore the cognitive processes underlying L2 pausing and revisions behaviours

2. Investigate potential links of fluency, pausing and revision to L2 writing product/text quality
Writing as an interactive and recursive process

Defined in terms of three sub-processes:

- formulation (planning the content and translating it into linguistic form)
- execution (producing the text using motor movements)
- monitoring (checking the resulting text).

Theoretical basis: Kellogg’s model of writing
When testing models of L2 writing, researchers have mostly relied on introspective protocols. However, data obtained by the means of concurrent verbalisations may be corrupted and distorted due to reactivity and thereby jeopardise validity.
Previous research on the writing process

Researchers increasingly utilise online computer recording of L2 writers' keystrokes and mouse movements to obtain information about online writing processes.

But keystroke logs cannot capture reading processes during writing.
Previous research on the writing process

e.g., Roca de Larios et al, 2008

Introspective methods

Writing process

Key-stroke logging

Eye-tracking

e.g., Leijten & Van Waes, 2013
The relationship between the writing process and product has received considerable attention in L1 writing research.

Only a few studies have been dedicated to exploring this association in the context of L2 writing.

Stevenson et al. (2006),
- looked into the relationship between text quality and online revision behaviour.
- identified no significant relationship between text quality and revision frequency in a study of Dutch high-school writers of English.

No research has looked into the link between pausing and text quality.
For Task 2 of the IELTS Academic Writing Test,

1. Are there any **relationships** between the **linguistic complexity** of the text produced and the **fluency**, **pausing**, and **revision** behaviours that L2 writers display?

2. What type of **eye movement behaviours** do L2 writers display when they **pause**?
Methodology: Participants

- 30 Chinese L2 users of English
- International students at the University of London enrolled in postgraduate programmes
- IELTS scores 7.0 or higher
- 27 females and 3 males
- Mean age: 26.6 (SD=3.70).
Methodology: Design

IELTS Academic Writing Task 2 N=30

Typing test N=30

Simulated recall N=12
Methodology: Design

IELTS Academic Writing Task 2 N=30

Typing test N=30

Simulated recall N=12
Going overseas for university study is an exciting prospect for many people. But while it may offer some advantages, it is probably better to stay home because of the difficulties a student inevitably encounters living and studying in a different culture.

To what extent do you agree or disagree with this statement? Give reasons for your answer and include any relevant examples from your knowledge or experience.

Write at least 250 words.
Talking about history and past, it is easy for always remains us of the e·representative events and people·involving·in·the·Movement·LEFTClick[Movement][LEFTClick]·war·so·negotiation·s·and·et
Data analyses: Pausing behaviour

Talking about history and past, may by now, we are talking about history and past, it is easy for always. It always remains us our minds of the representative events and people involving in the wars so, negotiations and so and et
Data analyses: Pausing behaviour

Talking about history and past, may we always remain and talk. When talking about history and past, it is easy for us always to remember the representative events and people involving in the Movement. Wars, negotiations, and so on.
Data analyses: Pausing behaviour

Talking about history and past, we are always reminded of the representative events and people involving in the war so that negotiations and other matters can be settled.
Data analyses: Pausing behaviour

Talking about history and past, may we are. We are always remainds us of the e representative events and people involving in the war so people's and et's and et's and et's.
Data analyses: Fluency

- **P-burst**
  - Number of words occurring between pauses
  - Number of characters occurring between pauses

- **Total writing time divided by words/ characters**
  - Minutes per word
  - Minutes per characters
Data analyses: Pausing behaviour

- **Mean length of pause**
  - Total
  - Within words
  - Between words
  - Between sentences

- **Number of pauses per 100 words**
  - Total
  - Within words
  - Between words
  - Between sentences
Data analyses: Revision behaviour

- **Total amount of revision**
  - number of words in final text / number of words produced
  - number of characters in final text/number of characters produced
Data analyses: Linguistic complexity

- **Lexical rarity (New GSL list)**
  - new GSL 1000 words, new GSL 2500 words, new GSL off-list

- **Lexical variability (CohMetrix)**
  - D-formula, textual lexical diversity (MTLD)

- **Lexical disparity (CohMetrix)**
  - Latent semantic analysis (captures conceptual similarity of each sentence to every other sentence in text)
Data Analyses: Syntactic complexity

- **Overall syntactic complexity**
  - Words per t-units (Synlex)

- **Subordination complexity**
  - Clause per t-units (Synlex)

- **Phrasal complexity**
  - Complex nominals per t-unit (Synlex)

- **Syntactic sophistication**
  - Syntactic structure similarity index (Cohmetrix)
Data Analyses: Eye-tracking

**Inputlog**
- identify pauses of >2000 ms

**Tobii Studio**
- find position in eye gaze movement
- review gaze behaviour before that point
- code for viewing at
  - word
  - clause
  - sentence
  - paragraph
  - off-screen
  - else (i.e., blank space after last word)
Example Video: Reading during pause (>2000ms) “Sentence”

Going overseas for university study is an exciting prospect for many people. But while it may offer some advantages, it is probably better to stay home because of the difficulties a student inevitably encounters living and studying in a different culture.

To what extent do you agree or disagree with this statement? Give reasons for your answer and include any relevant examples from your knowledge or experience. Write at least 250 words.

To a very large extent, I agree that studying abroad will leave exciting experience to students. No matter which countries students are from, it is inevitable that they would communicate with people from different walks of life. Such a cultural gap will create great learning opportunity becau
To a very large extent, I agree that studying abroad will leave exciting experience to students. The diversity in both learning and living would lead to changes in thinking. No matter which countries students are from, it is inevitable that they would communicate with people from different walks of life. Such a cultural gap will create great learning opportunity because students can see the same issue with a wide range of angles. Apart from viewing the issue on various perspectives, students would also learn the way of discussions, ranging from developing persuasive skills to
Going overseas for university study is an exciting prospect for many people. But while it may offer some advantages, it is probably better to stay home because of the difficulties a student inevitably encounters living and studying in a different culture.

To what extent do you agree or disagree with this statement? Give reasons for your answer and include any relevant examples from your knowledge or experience. Write at least 250 words.

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Correlational analyses were carried out to examine the relationships between linguistic complexity and the indices of fluency, pausing, and revisions.

The alpha level was set at .01.
For Task 2 of the IELTS Academic Writing Test,

1. Are there any relationships between the linguistic complexity of the text produced and the fluency, pausing, and revision behaviours that L2 writers display?

2. What type of eye movement behaviours do L2 writers display when they pause?
Out of the 40 correlations, only one reached significance:

\[ \text{writing time/words} \sim \text{clause/T-unit} \]
\[ (r = -.482; \ p = .007) \]

The more words participants produced per minute, the more syntactically complex texts they produced.

Not a surprising finding - more fluent writers produced more complex texts.
Results: Mean length of pause and linguistic complexity

Out of the 50 correlations, a few reached significance, all including *lexical rarity*:

- pause length total ~ **new GSL1000** \( (r = .491; p = .006) \)
- pause length between word ~ **new GSL1000** \( (r = .478; p = .007) \)
- pause length between sens ~ **new GSL1000** \( (r = .471; p = .009) \)

The longer participants paused overall, and between words and sentences; the more high frequency words occurred.

Longer pauses might have been the result of less automatized lexical access - an indicator of less advanced lexical knowledge. In turn, it is expected that those with less advanced lexical knowledge produce less sophisticated lexis.
Results: Number of pauses and linguistic complexity

A few significant correlations, including lexical rarity, overall syntactic complexity, and syntactic sophistication:

\[
\text{pause freq total} \sim \text{new GSL1000} \quad (r = .593; \ p = .001)
\]

\[
\text{pause freq within words} \sim \text{new GSL1000} \quad (r = .626; \ p = .001)
\]

The more participants paused, the more high frequency words they used.

\[
\text{pause freq between sens} \sim \text{word per t-unit} \quad (r = -.524; \ p = .001)
\]

\[
\text{pause freq between sens} \sim \text{syn struc sim} \quad (r = .527; \ p = .001)
\]

The more participants paused, the less syntactically complex language they produced.

Expected - less fluent writers may also have less advanced lexical and syntactic knowledge.
No significant relationships were found between amount of revision and any of the linguistic complexity indices.
Research questions

For Task 2 of the IELTS Academic Writing Test,

1. Are there any relationships between the linguistic complexity of the text produced and the fluency, pausing, and revision behaviours that L2 writers display?

2. What type of eye movement behaviours do L2 writers display when they pause?
These data suggest that participants engaged in both lower and higher-level writing processes (reading and monitoring) during pauses.
Next steps

- Complete eye movement analysis
- Triangulate eye movement data with fluency, pausing, and revision measures as well as stimulated recall comments
- Examine whether working memory capacity moderated the findings
Limitations and further research

- No measures of accuracy and communicative adequacy
- Limitations associated with stimulated recall methodology
- Threshold for pausing too long (2 s)?
- Also, it would be worthwhile to replicate this study with L2 users from different levels of proficiency and with different task types.
Many thanks to …

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