

# **The effects of stress on text comprehension and performance in examinations**

Dina Kiwan, Ayesha Ahmed and Alastair Pollitt  
University of Cambridge Local Examinations Syndicate

Paper presented at the BPS London Conference, December 1999.

The opinions expressed in this paper are those of the authors and should not be taken as official policy of the University of Cambridge Local Examinations Syndicate or any of its subsidiaries.

Contact details

Ayesha Ahmed, RED, UCLES, 1 Hills Road, Cambridge, CB1 2EU

# **The effects of stress on text comprehension and performance in examinations**

Dina Kiwan, Ayesha Ahmed and Alastair Pollitt  
University of Cambridge Local Examinations Syndicate

## **Summary**

This study aims to investigate the effects of time-induced stress on text comprehension, and the implications for performance in an examination setting. In the pilot phase, which has just been completed, we aimed to identify which features of language, context, or presentation, are more, or less sensitive to time-induced stress. We used a program called *Hypercard*, to present a narrative text on a series of computer screens to 4 participants, ranging in age from 10 years and 6 months to 11 year and 6 months. The participants were required to recall as much of the text as possible, followed by prompts to aid recall. Participants were then asked more specific questions to test their comprehension. Preliminary results from the pilot phase suggest that there are three key findings: i) participants had difficulty understanding who is narrating; ii) the use of schemas; and iii) participants had difficulty with the temporal sequence of the story.

## **Introduction**

A range of linguistic, conceptual and contextual features have been identified as contributing to comprehension difficulty, (Brown, 1986; Brown, 1989; Brown, Sharkey & Brown, 1987). There have also been a number of studies that have been conducted to identify stressful conditions: “conditions under which linguistic and contextual factors interact so that the linguistic message is relatively easy or relatively more difficult to understand” (Brown & Markman, 1991). Examinations are a source of stress in various ways, and there is considerable evidence in the literature that stress affects task performance, often negatively. One simple form of stress, which is relatively easy to manipulate (and relevant to the examination context) is time. This study aims to investigate the effects of time-induced stress on the process of pupils reading a text in an examination setting, and the resulting effects on their comprehension of this text.

A pupil’s ability to understand a text and the questions relating to it will inevitably affect their performance on these questions. The reader has to carry out processing at several levels – at the individual word level, at the sentence level, at the groups-of –sentences level, and at the text level (Gerrig, 1986). Reading a text and answering questions may be difficult for a number of reasons. The accessibility of the linguistic, contextual, and conceptual features in the text may cause difficulties in comprehension (Bell, 1995). For example, there may be unfamiliar words, complex syntax, temporal complexity, unclear or delayed identification of the referent, and the causes and/or intentions in the text may not be explicit, requiring the reader to be able to make inferences. There is a distinction, however, between the pupil’s ability to read a text with intended, and therefore valid ‘sources of difficulty’ in the task (Pollitt & Hutchinson, 1985), and invalid ‘sources of difficulty’. These are aspects of the text and/or questions that impede assessment of what the questions are intended to test. The primary function of a question is to instruct the pupil what to do; it should not itself be a source of serious difficulty.

In addition to linguistic, contextual and conceptual features that may cause difficulties in text comprehension, there is a sizeable body of research on the role of working memory in reading. It has been proposed that those readers who have difficulty comprehending a text may be less efficient at storing and processing information at the same time in the working memory system. As a consequence, it will be relatively more difficult for these readers to form a coherent model of the text (Oakhill and Cain, 1997). There have also been a number of studies suggesting that there is a strong relationship between comprehension ability and working memory capacity, but a causal link has not been established. (In fact, differential reading experience may lead to the relationship between working memory capacity and comprehension ability.)

Incomplete knowledge may also pose a problem for readers in their attempts to comprehend a text. In order to make inferences, the reader has to be able to use knowledge stored in memory, referred to as a *schema* (Bartlett, 1932). Schema theory proposes that information is gathered together into meaningful units, and that we have schemas for most things that we have experienced or encountered. A script is a memory structure that is composed of a sequence of actions that occur in a given stereotypical situation (Abelson, 1981). We were also interested in exploring the effects of stress on these processes, and we hypothesised that, under stress, pupils would be particularly likely to rely on commonly-held schema in their comprehension of the text.

Given that assessment methods are rapidly developing, and that computerised assessment techniques are becoming ever more widespread, we decided to explore the effects of stress on comprehension by presenting the text on a computer screen at different speeds. Computers are now widely used both at school and at home in the development of reading, with a variety of programs, (e.g. programs which provide practice for improving speed and fluency of word recognition, or practice for learning phonic skills) (Singleton, 1997). However, there has, as yet been relatively little research on using the computer for the assessment of reading. One study conducted by the National Council for Educational Technology (NCET) in 1995 compared a computerised test of reading comprehension with a conventional paper-based assessment. The main conclusions of this study were that with the computerised version of the test, the pupils (aged 7-10 years) were more motivated, and that there was greater objectivity of assessment.

A second study (O'Hara & Sellen, 1997) compared reading paper and on-line documents, focussing on the reading processes for the purposes of producing a written summary. They concluded that for such a task, reading on paper has the advantages of allowing the reader to annotate while reading, and to cross-refer between pages, thus facilitating a deeper structural understanding of the text.

We have just completed the pilot phase of this study. We aim to investigate the differential effects of stress using a program called *Hypercard* which presents the text on a series of computer screens. We hypothesised that the process by which pupils read and understand texts are particularly sensitive to time-induced stress. We aim to identify which features of language, context, or presentation, are more, or less sensitive to time-induced stress.

## **Method**

In this pilot phase, our aim was mainly exploratory, in which we attempted to:

- i determine three appropriate speeds (a 'low', a 'medium' and a 'high' speed) at which to set the computerised delivery of text.
- ii evaluate the suitability of the text for Year 6 pupils (10-11 years of age).
- iii identify potential linguistic, contextual, conceptual or presentational features that may contribute to comprehension difficulties under time stress.

Participants included 4 subjects (3 boys and 1 girl), ranging in age from 10 years and 6 months of age and 11 years and 6 months of age. Each participant was presented initially with three practice texts, to enable them to familiarise themselves with the computer paradigm, and to reduce performance anxiety. The software was programmed so that each practice text was presented at a different speed (2.5 words, 3.0, and 3.5 words/second), with each screen presenting one paragraph of the text at a time. The rate of presentation and the texts was counterbalanced across participants. After each practice text had been presented, the subjects were asked if they had been able to read all the text on each screen. This, in effect, was an informal calibration, allowing us to make an approximate assessment of the participants' optimal reading speed. Participants were then presented with the actual text, which was delivered at a rate that provided a moderate challenge (i.e. stress) to each subject. Participants were told that the actual text was longer than the practice texts.

For all texts, the title appears in the centre of the screen, and when the participant indicates that he/she is ready to start, the experimenter clicks on the mouse to bring up the short introduction that precedes each text. Again, participants can read this in their own time, and when they are ready to begin, the experimenter clicks on the mouse again to start the program. Each paragraph of the text appears on the screen, with a visual indicator at the bottom of the screen so that participants can monitor the time available to read what is on the screen. This visual indicator is in the form of a horizontal black bar that gradually turns white. When it has turned completely white, this means that there is no reading time left and the next screen automatically appears. This process repeats itself until the end of the text is reached.

This procedure was explained to each participant in the following manner:

*“Now you’re going to read a story on the computer. When we start, you will see the title of the story. When you’re ready, the introduction will come on the screen. Then when you’re ready, I’ll start the story. (Before you read the actual story, we’ll do a few practice ones together so that you get used to it.) When the story starts, you have to read what is on the screen before the next screen comes on. There is a black bar at the bottom of the screen that gradually turns white. When it turns all white, this means that your reading time is finished on this screen and the next screen will come on. You will have to read fairly quickly but you should still try and read everything properly, as we will be asking you about the story at the end.*

You don’t have to press any buttons on the computer. The next screen will come on by itself.”

The presentation of each practice text lasted approximately 1 minute. After each practice text, each participant was asked:

*“How was it? Could you read everything on the screen?”*

The actual text that participants were tested on is as follows:

## The Story<sup>1</sup>

**Introduction:** This story is about John and his family....

*We arrived back home just after John. We saw him park by the back door, take something out of his saddle-bag and run upstairs in front of us with it. He went straight into the bathroom. As John ran up the stairs, Mum called after him, asking him if he'd enjoyed his ride. He answered that it'd been great, and that he'd cycled forty-three miles. He shut the bathroom door behind him.*

*It was his turn to help to get the tea ready. I stayed in my room doing some revision. Dad called upstairs to ask me to get a clean table-cloth from the airing cupboard in the bathroom. John immediately bolted up the stairs, saying he'd get it. But I was already at the cupboard. I opened the door and something came at me in a fury, beating against my face. I screamed out and John pulled me to one side.*

*Mum followed him in, demanding to know what was going on. John was holding a grey pigeon. It fluttered frantically in his hands, its eyes bright with terror. I was still shaking. I'll never forget the thrust and flap of those wings across my face. Mum started to pull out dirty linen from the airing cupboard, asking how a bird had got in there. John replied that he'd put it there, and apologised, explaining that he and his friend Harry had found it on their ride. He explained that Harry had thought it was dead, but that he didn't, so he brought it home in his saddle-bag, and then put it in the airing cupboard to get warm.*

*Mum, who was still as upset as I was, shouted at John, calling him an idiot, and complained about the mess the bird had made in the airing cupboard. She told him to get it out. John just stood there with his hands clasped round the pigeon, holding it against his chest so that it looked strangely like a beating heart. Again Mum shouted that he should get it out, adding that she couldn't stand birds in the house. Then Dad, still floury from the pastry he'd been making with John, came in to see what was happening. He told John to get rid of it.*

*John became defensive asking, "What d'you mean, get rid of it?"*

*Dad told him to take it back to where he'd got it from. When John said he'd found it near Grindleford, which was miles away, Dad still insisted he get rid of it. John said he wanted his tea first. But Dad was firm, saying his tea could wait since he had to get rid of it first.*

*John's face looked pinched and white. I was the cause of the trouble with my screaming, and I could have helped him to get out of it. But I didn't. I was pleased that they had sided with me against him, protecting me from my fright. I told him that it was a stupid trick to play on me. He argued that it wasn't a trick, since he'd put it there to get warm. But Dad just steered him out onto the landing, telling him to clear off with it. I smiled at John as he went past, smug with victory.*

*He came into the room and flopped into an armchair, sprawling out his arms and legs. He was exhausted. His face was streaked with dirt where he'd been rubbing his eyes. He calmly stated that he'd brought it back. Dad came in from the kitchen and stood in the doorway, too angry to speak. John gently undid his jacket and brought out the bird that was nestling there.*

---

<sup>1</sup> Adapted extract from 'Granny was a Buffer Girl' by Berlie Doherty.

*He cradled it in his hands and it watched us quietly. Paddy, the cat arched his back, and bushed his tail out at it. I stroked him while he hissed.*

*Mum asked why he'd brought it back. John then told us how he'd taken it all the way back to where he found it, how he put it back in the trees in the Longshaw estate, and how it began to settle down spreading its wings out as he walked away. But then he decided to go back to see if it was alright. When he found it in the same place, and still in the same position, he picked it up and tossed it out to make it fly. But because it just dropped, John thought he'd killed it. He informed us that since it couldn't fly, he'd brought it home to look after it.*

*I told him that it wasn't his responsibility, but he retorted that it was, saying, "I found it. You don't expect me to just leave it there, do you, when it can't look after itself!"*

*I caught the quick look that passed between Mum and Dad, and couldn't fathom it. Mum pushed her books away wearily, and turned to Dad, "Give John his dinner. I think there's an empty carton in the car boot. I'll fetch it."*

After participants had finished reading the actual text (3-5 minutes), a delay was introduced to stabilise the memory of the text. This filler task\*, shown below, consists of 10 test items, in which the participants were required to 'circle the odd one out' out of four options, and explain their choice orally. As well as being a distractor activity, this task required semantic processing. This activity took approximately 2-3 minutes, and was administered by a second experimenter, whilst the first experimenter prepared materials and the tape-recorder for the recall and comprehension phase relating to the text.

**\*Circle the odd one out.**

**Example:** bracelet ring necklace pen  
**Pen is different. The others are jewellery.**

- |     |         |           |         |           |
|-----|---------|-----------|---------|-----------|
| 1.  | tea     | coffee    | bread   | milk      |
| 2.  | kitchen | bathroom  | bedroom | garage    |
| 3.  | green   | big       | blue    | red       |
| 4.  | fork    | spoon     | knife   | cup       |
| 5.  | water   | meat      | bread   | fish      |
| 6.  | car     | sheep     | train   | bicycle   |
| 7.  | Monday  | Thursday  | Sunday  | Tuesday   |
| 8.  | July    | Christmas | March   | January   |
| 9.  | book    | letter    | TV      | newspaper |
| 10. | uncle   | friend    | sister  | mother    |

After participants had completed the filler task, they were told that they would be asked some questions on the story:

“Now I’m going to ask you about the story and I’m going to tape it because I won’t remember everything and so that I don’t have to make notes:”

*A microphone was then clipped to the participant, and the following questions were asked:*

***(General Comments – “how was it?”)***

***A/ Free Recall***

***Can you retell the story to me, in as much detail as you can remember?***

Before, starting with the prompts and the questions, participants were told that they would be going through the story again in order to extract a few more details. This was to provide a rationale for what may have been perceived by participants to be a repetitive exercise:

*“Now I’m going to ask you for a few more details so it may feel like you’re repeating yourself, but let’s just go through it to try and remember as much as you can.”*

***B/ Prompts***

*Who do you think is telling the story?*

*Can you remember any more details about John arriving home at the start of the story?*

*Can you remember anything more about what happened when Dad asked for a table-cloth?*

*Can you remember anything more about how John’s brother/sister felt (when he found the bird)?*

*Can you remember anything more about how Mum felt (when she saw the bird?)*

*Why did John bring the bird home?*

*Can you remember anything more about what John was told to do?*

*How do you think John felt about this?*

*And what about John’s brother/sister – how did he/she feel?*

*Can you remember anything more about what John did next?*

*Can you remember anything more about what happened at the end of the story?*

### *C/ Questions*

At the start of the story, who arrived home first?

*Why did John put the bird in the airing cupboard?*

*What did John have to do before his tea?*

*What did John do when his Dad told him to get rid of the bird?*

*(Why did John bring the bird back the second time?)*

*How did John's Dad feel when John brought the bird back the second time?)*

*At the end of the story, what do you think happens next? Why?*

Participants were initially asked to recall as much as possible, followed by prompts to aid recall. Then participants were asked more specific questions to test their comprehension. On completion of the above (a further 10-15 minutes), each participant was given a Mars bar as a token of appreciation for taking part in the study.

### **Results and Discussion**

Participants were able to familiarise themselves with the paradigm of the computer presentation using the practice texts. These practice texts were typically presented at three different speeds: 2.5, 3.0, and 3.5 words/second. According to their responses to the question, "Did you manage to read everything on the screen?", we were able to determine an appropriate presentation speed that would challenge the participant. One participant was presented the actual text at a speed of : 2.5 words/second, two participants were presented it at 3.0 words/second and one participant at 3.5words/second.

All four participants satisfactorily completed the filler task with little difficulty, although one participant required prompting on two of the items.

The taped recordings of the responses of all the participants on the recall task, followed by the prompts and questions were transcribed.<sup>2</sup> Several key issues emerged from a qualitative analysis of these transcriptions:

- i) difficulty understanding who is narrating
- ii) the use of schemas
- iii) difficulty with the temporal sequence of the story

i) Two out of the four participants had difficulty identifying the narrator of the text, in response to the direct question, "Who do you think is telling the story?" One participant was

---

<sup>2</sup> See Appendix for transcriptions for the four participants.



reasonably able to recall the story, which he did from the viewpoint of an observer. Yet in response to the above question, he became confused, saying "...is it...is it him? No, his Mum first...I think sometimes it's him and sometimes it's his Mum." The second participant spontaneously provided the term, 'narrator', yet when prompted, he tentatively suggested that the narrator was 'John', the main character. It may be that, under conditions of stress, simplification occurs, with recall of only the key characters, and no new characters are introduced. Indeed, the first participant mentioned above stated that there were three characters in the story – 'John', 'Mum' and 'Dad', and the second participant mentioned only two characters – 'John' and 'Mum'. The other two participants, a boy and a girl, both make the inference that the narrator is John's brother, even though there is no explicit reference in the text that the sibling is a brother rather than a sister.

ii) The use of schemas is particularly evident with two of the participants. Firstly, typical schemas relating to the roles of 'Mum' and 'Dad' appear to have had an influence on the recall and understanding of the text. One participant recalled that "Mum went down to make dinner", even though there is no explicit mention of what 'Mum' is actually doing, and in fact, the text explicitly states that it is 'Dad' who is getting the tea ready. In addition, a second participant recalls that 'Dad' plays the assertive, decision-making role telling John to get rid of the bird, even though in the text, 'Mum' tells him to get it out before 'Dad' does. It is also interesting to note that 'Mum' has a more prominent role than 'Dad' in the retelling of the story. In fact, in one participant's recall there is no mention of 'Dad' at all.

A second schema that may be coming into play could be a schema relating to sibling rivalry. Two of the participants suggest that the narrator is a brother rather than a sister. It could be that they are using a schema relating to sibling rivalry that may be stronger between brothers, rather than between a brother and a sister.

Thirdly, it is interesting to note that two of the participants recall that 'John' locks the bathroom door, even though this is not mentioned in the text. This could be due to the participants having a schema for 'going to the bathroom' that includes locking the door. However, it seems, that at least for one of these participants, the word 'bolted', used a few sentences later, in a different context – 'John *bolted* up the stairs', has been incorporated into the schema of 'going to the bathroom': In response to the question, "...What happened when Dad asked for a tablecloth?", the participant responded "Um...John bolted ...bolted up the, um, the door...so John's brother had to do it."

Finally, there may be some evidence for participants exhibiting a simplified understanding of the emotions expressed by the characters in the text. They may be using very broad schemas of 'positive' versus 'negative' types of emotion. The participants appear to be aware that there are mostly negative emotions being portrayed in the text, but seem unable to clearly distinguish between them. For example, two participants note only that 'Mum' was 'annoyed' or 'angry', but do not seem to be able to comment on the emotions exhibited by the other characters. In addition, one participant tentatively suggested that John's brother was 'angry', and 'Mum' was 'scared' on finding the bird; and in response to the question "How did John's Dad feel when he brought it back a second time?", he at first said that he couldn't remember, and then again tentatively suggested "I think he was angry."

This evidence suggests that when under stress, pupils are more likely to utilise a pre-existing memory structure that incorporates stereotypical information relevant to comprehension of a

particular concept, role, or situation. This schematic information tends to be stereotypical as it has been abstracted over a number of different occasions (Gerrig, 1986). Participants may be utilising these automatic schemas that are not modified due to the time stress, and also because they may only be deriving partial information from the text due to lack of time.

iii) This text is complex in terms of its temporal sequencing of events. Towards the end of the text the third paragraph before the end is out of temporal chronological sequence. This paragraph recounts events that actually occur before the events recounted in the paragraph starting 'He came into the room...'. In addition, there is a significant jump in time between the end of the preceding paragraph ending in '...smug with victory' and this paragraph starting 'He came into the room...'.

Only one participant was able to recount a relatively coherent story incorporating these difficult temporal aspects of the text. The other three participants did not realise that 'John' had in fact taken the bird back and returned before he had his tea. Participants were not prompted relating to these events towards the end of the story if they did not exhibit an understanding of the events in their initial recall or during the course of being prompted.

Given that the computer program presents the story in paragraphs, with approximately one paragraph/screen, it could be that this presentation may have made the task of forming a coherent overview of the temporal sequencing in the text more difficult, and especially under time stress. It could, however, be that this text is just too difficult for 10-11 year olds. The cues in this paragraph are very subtle in the form of the past perfect tense 'he'd'. In fact, some of the verbs in this paragraph are not always in the past perfect tense, simply for stylistic reasons – that repeated use of the past perfect would read awkwardly. We intend to investigate these possibilities in the next phase of the study by introducing a number of control conditions: the first condition would be the 'non-stress' condition – participants themselves would be able to control the rate of presentation of the text on the screen; the second condition would be the 'paper' condition, where a break in the text could be marked by an increased space, and participants would be able refer back through the text if they needed to, and the third condition could be a 'scroll-down' condition, in which the whole text is presented on the screen, which would scroll down automatically. Yet another condition - the 'direct speech' condition could include the original version of the above text which is predominantly composed of direct speech. It could be that this version may cue in the temporal aspects of the text to a greater extent than our adapted version that we have used in this pilot. Alternatively, this text could be trialled on an older cohort of pupils – aged 13-14 years.

Implications for the next phase:

*In addition to the above-mentioned controls that would be introduced, we propose to introduce some further prompts. These prompts would be more precise, focussing on specific details. This is because there were many details in the text that the subjects omitted, and it was not possible to determine what had been forgotten or misunderstood.*

*Possible prompts could be:*

Do you remember anything more about:

- 'the table-cloth'
- 'flour/pastry'
- 'flapping'

- 'a trick'
- 'Harry'
- 'smug with victory'

What do you think this means:

- *'I caught the quick look that passed between Mum and Dad, and couldn't fathom it. Mum pushed her books away wearily, and turned to Dad, "Give John his dinner. I think there's an empty carton in the car boot. I'll fetch it."*

Given that this study is still at the pilot phase, conclusions must be very tentative. The strongest finding appears to be that, when under stress, pupils are particularly likely to use schemas to structure their understanding and recall, even when these do not match with explicit references in the text. One could venture to raise the controversial question of whether introducing non-stereotypical situations within texts in examination conditions (i.e. under conditions of stress) is actually introducing an invalid 'source of difficulty'. Is it appropriate to use texts with non-stereotypical situations or characters with non-stereotypical roles in examinations? Or should such texts be reserved for use only in teaching and learning settings? If, for example, the aim of an English exam is to assess certain skills, such as retrieval of information, inference, synthesis, comment on language, etc, then the text is the vehicle through which these skills are assessed and should not introduce further, unrelated invalid sources of difficulty.

This can apply to questions in other disciplines. This issue is exemplified by a question from a 1999 GCSE paper in Chemistry:

*Put a ring around the name of an element which is in the same period as sulphur*  
*fluorine*  
*magnesium*  
*oxygen*  
*potassium*

The correct answer is *magnesium*, yet most students gave the answer, *oxygen*, even though they had access to the periodic table. Students tended to make this error because questions relating to the periodic table usually refer the *group*, rather than the *period* that an element is in. In fact, this question initially misled a marker marking this question. This is because the word, *period*, was unexpected, a less familiar concept.

It should be noted however, that it is a difficult task to always determine what a 'stereotypical' situation or role may be, and hence difficult to clearly determine which text or question may contain 'non-stereotypical' situations, roles or concepts, and hence 'invalid' sources of difficulty.

### References:

- Abelson, R. P.(1981). Psychological status of the script concept. *American Psychologist*, **36**, 715-29.
- Bartlett, F. C.(1932). *Remembering*. Cambridge: Cambridge University Press.
- Bell, J. (1995). *What makes language difficult to understand? UCLES notes*.

- Brown, G. (1986). Investigating listening comprehension in context. *Applied Linguistics*, **7**, 284-302.
- Brown, G. (1989). Making sense: The interaction of linguistic expression and contextual information. *Applied Linguistics*, **10**, 97-109.
- Brown, G., & Markman, S. (1991). Discourse processing and preferred information. *Linguistics and Education*, **3**, 47-62.
- Brown, G. D., Sharkey, A., & Brown, G. (1987). Factors affecting success of referential communication. *Journal of Psycholinguistic Research*, **16**, 535-549.
- Gerrig, R (1986). Text Comprehension in *The Psychology of Human Thought*. R. Sternberg, and E. Smith (Eds.) Cambridge: Cambridge University Press.
- Oakhill, J., & Cain, K. (1997). Assessment of comprehension in reading. In *The Psychological Assessment of Reading*. J.R. Beech & C. Singleton (Eds.). NY: Routledge.
- O'Hara, K., & Sellen, A. (1995). A Comparison of Reading Paper and On-Line Documents. *Proceedings of CHI 1997 conference, Atlanta, GA*.
- Pollitt, A. & Hutchinson, C. (1985). The Validity of Reading Comprehension Tests: What Makes Questions Difficult? In *Assessing Reading*, Proceedings of the UKRA Colloquium on the testing and Assessment of Reading.
- Singleton, C.(1997). Computer-based assessment of reading. In *The Psychological Assessment of Reading*. J.R. Beech & C. Singleton.(Eds.) NY: Routledge