Text integration processes in children with Childhood Epilepsy with Centro-Temporal Spikes

Author names and affiliations

Gillian Francey[1], Nicola Currie[1], Adina Lew[1], Christian De Goede[2,3], Helen Basu[3], Kate Cain[1].

1 Department of Psychology, Lancaster University, Bailrigg, Lancaster LA1 4YF, UK

2 Department of Health Research, Lancaster University, Bailrigg, Lancaster LA1 4YX, UK

3 Paediatric Neurology Department, Royal Preston Hospital, Sharoe Green Lane North, Fulwood, Preston PR2 9HT, UK

Corresponding author email: k.cain@lancaster.ac.uk

Additional authors' email addresses

Gillian Francey, g.francey@lancaster.ac.uk

Nicola Currie, ncurrie2@ed.ac.uk

Adina Lew, a.r.lew@lancaster.ac.uk

Christian De Goede, christian.degoede@lthtr.nhs.uk

Helen Basu, helen.basu@lthtr.nhs.uk

Final version submitted to journal. Accepted 05/04/2023.

Abstract

Although Childhood Epilepsy with Centro-Temporal Spikes (CECTS) is considered a 'benign' form of epilepsy, word reading, listening comprehension, and reading comprehension difficulties have been reported. We examined two core skills for text comprehension, coherence monitoring and inference generation, in children with CECTS and compared performance with typically developing controls. Children with CECTS (n=23; 9 females; mean age 9y 0m) and the comparison group (n=38; 14 females; mean age 9y 1m) completed two tasks. For coherence monitoring they heard 24 narrative texts, 16 containing two inconsistent sentences, and responded to a yes/no question to assess identification of the inconsistency after each text; for inference making they heard 16 texts designed to elicit a target inference by integrating information in two sentences and responded to a yes/no question to assess generation of the inference. In both tasks there was a near condition, in which critical sentences were adjacent, and a far condition in which these sentences were separated by filler sentences. Accuracy to the question and the processing time for critical sentences in the text were measured. We used listening comprehension tasks to control for variation in word reading ability. Mixed effects analyses for each task revealed that children with CECTS show comparable levels of accuracy to age-matched peers in these tasks tapping two core text integration skills: detection of inconsistencies and generation of inferences. However, they take longer to process texts indicating a likely source of their listening and reading comprehension difficulties.

Keywords: Childhood Epilepsy with Centro-Temporal Spikes, text integration, Listening comprehension, Reading comprehension, Processing time.

1. Introduction

Childhood epilepsy with centro-temporal spikes (CECTS), also known as rolandic epilepsy or benign childhood epilepsy (BECTS), is the most commonly diagnosed form of epilepsy in children, reported to account for 8% to 25% of all childhood epilepsies [1, 2]. The onset occurs between 3 and 13 years and seizures usually recede before the age of 16 [2]. Children with CECTS have an increased risk of word reading and reading comprehension difficulties [3, 9]. In contrast to a large literature documenting the language and memory profiles of children with CECTS (e.g., [2, 4, 5]), we do not know of any research examining the text integration skills that enable successful comprehension of text. Such information is necessary to inform targeted educational interventions to mitigate the impact of their weak reading and listening comprehension skills on educational outcomes and future employment.

This paper focuses on text integration skills that are essential for successful reading and listening comprehension. We use ‘text’ to refer to both aurally and visually presented passages. Theoretical models of text comprehension do not differentiate between the two modalities [6] because, beyond word reading, the skills that support listening comprehension also underpin reading comprehension [7, 8]. Word reading and listening comprehension each make an independent contribution to the reading comprehension performance of children with CECTS [9], and also children who do not have epilepsy [10]. Some children with CECTS have word reading difficulties [2, 9] so, in this study, we assess core text integration skills in the aural modality to mitigate the confound of word reading.

The language associates of poor reading and listening comprehension in children who do not have epilepsy are well-established and include weaknesses in the comprehension of single words (vocabulary) and sentences (grammar) [11, 12]. Poor performance in these language domains is common in children with CECTS [2, 4, 5]. In the current study we focus on two discourse-level language skills that are critical for successful reading and listening comprehension - coherence monitoring and inference making. These discourse-level skills enable readers to integrate the meanings of the words and sentences in a text to construct a coherent mental model of the text's overall meaning [13]. Coherence monitoring concerns an individual's awareness of the adequacy of their understanding of a text, and is essential to detect unfamiliar words and to integrate each successive piece of information from a text into their mental model [14]. Inferences are made when individuals generate the information necessary to link ideas within a text, or between the text and their prior knowledge, to establish an integrated and coherent mental model [15]. These integrative processes are theorised to be the 'keystone' of successful text comprehension [16] and are critical to both reading and listening comprehension.

The critical importance of coherence monitoring and inference generation to text comprehension in children without epilepsy is well established. Measures of coherence monitoring predict performance on reading and listening comprehension concurrently and longitudinally over and above an individual's word reading, vocabulary, and grammar skills [7, 17]. Coherence monitoring is weak in children with poor reading comprehension [18, 19], and reading and oral language-based interventions that include instruction in strategies to support coherence monitoring result in improved reading comprehension [20, 21]. Similarly, inference generation predicts performance on standardised measures of reading comprehension in children, adolescents and adults [22-24] and is weak in children and adults with poor comprehension skills [25, 26]. Furthermore, training in inference making improves performance on standardised measures of reading comprehension [27]. Together, these research findings identify these two skills as critical components of intervention for children with poor text comprehension, and for inclusion in classroom curricula to mitigate for those at-risk of poor comprehension. We do not know if the same is true for children with CECTS, whose poor reading and listening comprehension may result from other language or cognitive difficulties. Thus, to date, we lack the information needed to inform targeted interventions to foster good text comprehension in children with CECTS.

Coherence monitoring and inference directly support the construction of the mental model of the text because text comprehension is a dynamic process. Text comprehension happens in real time; as each new piece of information is presented, the reader or listener seeks to integrate its meaning with the mental model of the text's meaning constructed so far. Therefore, an additional factor to consider when assessing the real time comprehension of text is the time taken to process relevant information. Children with CECTS respond more slowly on processing tasks such as verbal fluency [28-31]. In a similar manner slower processing speed could impact performance on text integration skills, which rely on efficient access to relevant words and concepts in sentences in real time. Therefore, and novel to our study, we collect both accuracy and response time data in order to obtain a sensitive assessment of the text integration skills of children with CECTS.

1.1. The current study

We examined the text integration skills of children with CECTS using tasks to assess coherence monitoring (Experiment 1) and inference generation (Experiment 2). Each task comprised a series of short passages presented aurally, rather than visually, to mitigate for the word reading difficulties, which are common in children with CECTS [2, 9]. Our approach is justified by both theoretical accounts of text comprehension [6] and also the strong statistical associations between performance on listening and reading comprehension tasks when word reading ability is suitably controlled [31-33]. In both tasks, sentences were presented one at a time, and participants pressed a button on a response box to hear the next sentence. To provide an insight into the dynamics of text integration, we recorded the time taken to both process each sentence and respond to the question at the end of each passage. Typically, longer times reflect a greater effort to process the information and serve as a signal of integration difficulties [34]. Responses to a yes/no question after each passage were designed to provide a measure of accuracy, or the quality of comprehension (typically referred to as the product) and whether the child had effectively monitored their comprehension or generated a target inference, as required by the task. By assessing both the *process* and *product* of comprehension we stand to gain greater insight into the nature of any difficulty children with CECTS may (or may not) experience on these tasks.

2. Experiment 1: Coherence Monitoring

2.1. Introduction

Coherence monitoring was assessed with an error detection task, in which individuals were presented with passages that included deliberate anomalies, in this case two sentences that stated contradictory information. After each passage, participants responded to a question to evaluate whether or not they had identified the anomaly. Such tasks in both visual (reading) and aural (listening) presentation formats are sensitive to individual differences in coherence monitoring and reading comprehension [17, 35]. We manipulated the difficulty of the task by increasing the distance between the inconsistencies. Increasing the distance between pieces of information to be integrated, decreases the likelihood that children and young adolescents will detect an inconsistency [19, 36]. In line with previous research, we predicted that the distance manipulation – designed to create an increase in processing load, would increase task difficulty, resulting in longer processing times for sentences, response times to questions, and lower accuracy for the questions. If participants with CECTS have difficulties with text integration, they should perform more poorly on this task than the comparison group who did not have epilepsy. If their difficulties arise at the time of integration, we should observe longer processing times for sentences as they are presented. If their difficulties impact on their overall quality of understanding, we should observe lower question answering accuracy. If they have impaired access to the target information in the mental model they have constructed while listening to the text, we should observe slower response times to questions.

2.2. Method

2.2.1. Participants

Children with CECTS were identified between October 2013 and December 2014 at 11 participating hospital trusts in northern England. The inclusion criteria were children aged between 6 years and 12 years with at least two observed seizures and confirmatory electroencephalography, as assessed by a paediatric neurologist (CdeG, HB, or AI). All spoke English as their primary language and were schooled in English. For further details on recruitment of the sample, and more specific details regarding their epilepsy characteristics, please see [9]. Twenty three children with CECTS, from the original sample, completed the tasks for this study and were included in our analyses (see Table 1).

The comparison sample was recruited from three mainstream primary schools in the northwest of England and by research study advertisement at [redacted] University. They had no known neurological or neurodevelopmental conditions, or diagnosed reading difficulties (on the basis of parental report), and spoke English as their primary language and were schooled in English. From 60 initial recruits, only those with a birthday within 6 months of a child with epilepsy and the same sex and school year were included in the data analyses reported here. As a result, all children with CECTS had at least one match but some had several matches; one child did not have a sex match. This gave us an overall control sample of 38 (see Table 1).

An a priori power analysis indicated that a sample of 13 participants with CECTS would be adequate to detect differences in accuracy performance, with an 80% chance of avoiding a type II error, based on the effect sizes obtained in nonclinical samples of poor comprehenders [37]. Our final sample exceeded this criterion. A National Health Service Research Ethics Committee (North West - Liverpool East) and a University Research Ethics Committee approved the study. Parents of children with CECTS and those in the comparison group gave written consent, and children gave verbal consent before the start of testing.

Table 1

Participant characteristics

	CECTS (n = 23)	Comparison (n= 38)
Sex, male/female	14/9	24/14
Mean age, y:mo (SD)	9: 0 (1: 6)	9: 1 (1: 3)
Age at onset, y:mo (SD)	6: 10 (1: 10)	
Seizure frequency (n, %)		
Less than monthly	19 (83.0%)	
Monthly	3 (13.0%)	
Weekly	1 (4.0%)	
Antiepileptic medication[a]		
None	12 (52.2%)	
Monotherapy	10 (43.5%)	
Polytherapy	1 (4.3%)	

Comorbid diagnosis (n)[b]	
None	18 (78.3%)
Present	5 (21.7%)
Laterality[c]	
Right	8 (34.7%)
Left	4 (17.4%)
Bilateral	11 (47.8%)
Evolving	4 (17.4%, 1 left, 3 bilateral)

The same children who participated in Experiment 1 completed Experiment 2 with the following exceptions: one child from the CECTS group and two in the comparison sample were available for only the coherence monitoring and not the inference generation task; one child in the comparison group was available for only the inference generation and not the coherence monitoring data collection. [a]Antiepileptic medication: Monotherapy included Carbamazapine (n=4), Keppra (n=1), Levetiracetam (n=2), Lamotrizine (n=2), Sodium Volprate (n=1). Polytherapy included Carbamazapine and Buccal Mydazopam (n=1). [b]Comorbid diagnoses: one with anxiety, one with attention-deficit- hyperactivity-disorder and resolved hearing difficulty, two with autism spectrum disorder, and one with movement disorder. [c]In 78% of cases, laterality was fully confirmed by electroencephalography. Information from a parental questionnaire indicated low incidence of Speech Sound Disorder (n= 3) and referral for speech therapy (n=5) in the CECTS group. The date of the last known seizure was within two years of the beginning of the recruitment drive for 19 participants but not provided for the other 4 participants.

2.2.2. Measures and Procedure

Children were assessed in school, at home, or at the University, based on parental preference. Assessments were always conducted in a quiet environment and the same order of assessments was used with breaks at appropriate times to avoid distraction and fatigue. Each child listened to eight consistent and 16 inconsistent six-sentence narrative passages written for this age group. The passages concerned human characters and events focused on typical activities for children, such as parties, schools, and friendships. The materials were recorded using Audacity software. Children listened to each passage, sentence by sentence, while viewing the sentences on a laptop via E-Prime 2.0. Children advanced to each new sentence by pressing a key on an E-Prime button box.

The processing load for the inconsistent passages was manipulated by placing the sentences containing contradictory information either adjacent to each other (near condition, low processing demands) or two sentences apart (far condition, high processing demands) following precedents in the literature [35]. The inconsistent passages were counterbalanced across two presentation lists to ensure that each participant read only one version of each inconsistent passage (to avoid priming) and completed eight in each condition. The same eight consistent passages were used in both lists. Examples are provided in Table 2.

After each passage, participants answered a yes/no question (Did this story make sense?) to assess their detection of the inconsistency, if one was present. Two practice passages with feedback were completed before the experimental materials. There were three outcome variables: (a) accuracy to the sense question for all conditions: consistent, inconsistent near, inconsistent far; (b) response time to the sense question for all conditions; and (c) processing time for consistent and inconsistent sentences within the inconsistent texts (conditions: consistent near, inconsistent near, consistent far, inconsistent far).

Table 2

Examples of passages in the consistent and the inconsistent conditions

Consistent
Amy and her friends like building dens in the park.
On Monday Amy's friends asked her to go and play after school.
There were swings and slides at the park as well.
Amy had her new shoes on and didn't want to get them dirty.
Amy said she would have to go home first to change out of her new shoes.
Amy ran home as quickly as she could.

Inconsistent –Near
1. Grandma has moved to a new house.
2. She has painted all of the walls in her new house pink.
3. Grandma is happy that the new house has a garden.
4. Grandma likes her new bedroom because it is big.
5. Grandma's bed did not fit into her new bedroom because the room is small.
6. She is having a party to show the house to her family.

In the inconsistent far condition, sentences 2 and 3 were inserted between sentences 4 and 5, so the order was: 1, 4, 2, 3, 5, and 6.

SENSE QUESTION: Did this story make sense?
Correct response = yes for consistent passages, no for inconsistent passages.

2.3. Results

2.3.1. Sense question accuracy

The mean proportions of correct responses to the sense question (yes for consistent passages; no for inconsistent passages) in each condition are reported in Table 3. Responses made before the end of the question were included because the question was always the same so it could be reasonably anticipated[1]. The means indicate that the children with CECTS were less likely to provide an accurate response than the comparison group and that performance was lowest for inconsistent passages in the far condition.

[1] Excluding question responses before the end of the question would have resulted in 11.95% data loss (10.63% of question responses for comparison children and 14.13% of question responses for children with CECTS).

Table 3

Mean proportion of correct responses (and standard deviations) to the sense question

	Group						
	Comparison			CECTS			Total
Condition	M	Min	Max	M	Min	Max	
Consistent	0.81 (0.40)	0.38	1.00	0.74 (0.44)	0.13	1.00	0.78 (0.41)
Inconsistent Near	0.81 (0.39)	0.25	1.00	0.71 (0.45)	0.13	1.00	0.77 (0.42)
Inconsistent Far	0.68 (0.47)	0.13	1.00	0.71 (0.45)	0.25	1.00	0.69 (0.46)
Total	0.77 (0.42)			0.72 (0.45)			

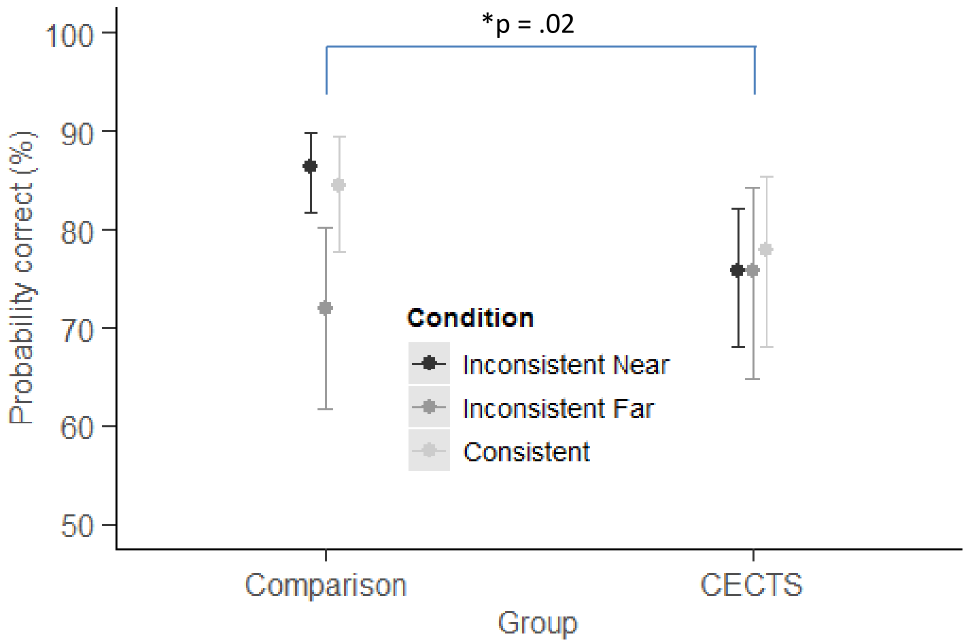
The sense question accuracy data were analysed with (generalised) linear mixed-effects models (GLMMs) using the lme4 package for R [38]. A linear mixed model approach allows inclusion of both random intercepts for subjects and random intercepts for items. The results can, therefore, we generalised to new samples of both participants and items, which a standard by-subjects ANOVA cannot do. Models were fitted to estimate the effects of group, condition, and the interaction between these factors, influencing the log odds that a child's response to the sense question would be correct, while taking into account random effects associated with differences between sampled children or items. The categorical predictor variables were contrast coded. The model specified with maximal random effects structure (cf. [39]) did not converge so we report the model which did converge and included random effects warranted by the data [40]. These were random effects corresponding to by-participant deviations in intercepts and in the effect of condition, and by-item deviations in intercepts (see Appendix Table A1 for the model summary).

Participants were more likely to answer the sense question correctly than incorrectly. This is indicated by the positive, significant intercept coefficient (B = 1.34, SE = 0.17, z = 7.68, p < .001). The children with CECTS were less accurate than overall sample accuracy (shown by the positive group effect B = 0.15, SE = 0.12, z = 1.24) and the comparison group was more accurate, however the effect was not statistically significant (p

= .21). Sense judgements were significantly less accurate for passages where inconsistencies were separated (far condition) compared to overall accuracy. This is indicated by the significant negative coefficient for the inconsistent (far) condition (*B* = -0.29, *SE* = 0.14, *z* = -2.14, *p* = .03). This main effect was qualified by the significant interaction of group x condition (far) (*B* = -0.26, *SE* = 0.11, *z* = -2.38, *p* = .02). The nature of the interaction is revealed in the partial effects plot (see Figure 1) and was also examined by sub-setting the data by group. Here we report estimates (but not *p* values) to provide an indication of average differences between conditions in sense question accuracy. Examination of the group x condition (far) interaction suggests that sense question accuracy for the children with CECTS did not differ by condition: *B* = -0.07, *SE* = 0.17, *z* = -0.39; *B* = -0.07, *SE* = 0.18, *z* = -0.39, for near and far inconsistent passages respectively. In contrast, performance of the children in the comparison group was influenced by condition: They were more accurate for near inconsistent passages (*B* = 0.38, SE = 0.18, z = 2.08) and less accurate for far inconsistent passages (*B* = -0.56, *SE* = 0.17, *z* = -3.26) compared to their average performance across both conditions (see Appendix Table A2 and Table A3 for model summaries).

Figure 1

Sense question accuracy (with standard error): Group x Condition interaction



2.3.2. Sense question response times for correct responses

Sense question response times for correctly answered questions are reported in Table 4. This was recorded as the time from the beginning of the sound file for the question to when a participant pushed the button to respond to the question. As above, correct responses made before the end of the question sound file were included because the question was always the same so it could be reasonably anticipated[2]. The means indicate that children with CECTS took longer to respond than did the comparison group. Of note is the significant variation in response times (indicated by the SDs).

Table 4

Sense question response times (and standard deviations) in each condition (ms): Correct responses

	Group

[2] Excluding question response times before the end of the question, for correctly answered questions, would have resulted in 11.95% data loss (11.03% of question response times for comparison children and 13.57% of question response times for children with CECTS).

Condition	Comparison	CECTS	Total
Consistent	2970.53 (2135.25)	3348.51 (2828.71)	3105.45 (2408.96)
Inconsistent Near	2792.39 (2965.06)	3998.66 (6336.03)	3210.43 (4462.09)
Inconsistent Far	2556.35 (1972.03)	3613.56 (3738.04)	2967.31 (2836.42)
Total	2785.25 (2422.88)	3649.74 (4529.23)	

Sense question response times for correct responses were analysed using linear mixed-effects models (LMMs) using the lme4 package for R [38]. The final model included the same fixed effects, interactions and random intercepts as the question accuracy model, but without random slopes to control for between-participant differences in the effect of condition (see Appendix Table A4 for the model summary). There was a statistically significant effect of group (B = -512.99, SE = 213.29, t = -2.40, p = .02): The children with CECTS took longer to respond than the children in the comparison group. No other effects or interactions reached statistical significance.

2.3.3. Sentence processing times within inconsistent passages

We examined the processing time of each inconsistent sentence (sentence 5) in the near and far inconsistent conditions and the response time of the sentence located immediately prior to this sentence in the same passage (sentence 4). This analysis was performed only for those items for which participants had made a correct sense judgement to the question after the passage (just over 70% of all items). Sentence 4 was assumed to have been processed under "consistent" conditions because it occurred prior to the inconsistent sentence. Sentence processing time was recorded as the time to push the button to hear the next sentence after the sound file for the current sentence had been heard in its entirety[3].

Sentence processing times when the sense question was answered correctly are reported in Table 5. All times were within +/-3 SDs of an individual's condition mean. The means indicate that children with CECTs were slower to move on to the next sentence in general, and that children in both groups were faster following consistent sentences than inconsistent sentences, although the effect was more pronounced for the comparison group. (See Table S1 and S2 supplementary materials for the mean sentence processing times for incorrect sense question responses and analysis).

Table 5

Consistent and inconsistent sentence processing times (and standard deviations) in each condition (ms): Correct Responses

			Group		
Response	Condition	Sentence Type	Comparison	CECTS	Total
Correct	Near	Consistent	669.18	1011.72	785.89
			(399.70)	(1376.11)	(879.40)
	Near	Inconsistent	1071.55	1147.47	1096.86
			(744.00)	(1112.00)	(883.02)
	Far	Consistent	677.23	1007.67	804.32
			(440.58)	(1103.08)	(781.56)

[3] Excluding sentence processing times before the end of the sentence, for correctly answered questions, resulted in 3.85% data loss (2.53% of sentence processing times for comparison children, 6.11% of sentence processing times for children with CECTS).

Far	Inconsistent	1125.75 (1270.30)	1344.76 (1546.98)	1208.47 (1383.07)
Total		886.12 (806.43)	1126.94 (1300.44)	

As for the question response time data, we used LMMs to model the fixed effects of group and condition on processing time for sentences in passages for which children had made a correct sense judgement. We also included the effect of sentence type (consistent, inconsistent). Models included random effects accounting for by-participant differences in intercepts, effects of condition and sentence type, and by-item differences in intercepts (see Appendix Table A5 for the model summary).

The children with CECTS took significantly longer to process sentences than children in the comparison group (*B* = -145.21, *SE* = 70.10, *t* = -2.07, *p* = .04). There was also a significant effect of sentence type because participants were faster to process consistent compared to inconsistent sentences, in general (*B* = -182.51, *SE* = 40.33, *t* = -4.53, *p* <.01). There were no other signifancant effects or interactions.

2.4. Discussion

Children with CECTS were not significantly less accurate than age matched comparison children to evaluate whether or not a passage made sense. However, they took significantly longer to answer the sense question and to process critical sentences within the passage than the comparison group to achieve this level of performance. This pattern of findings suggests that children with CECTS are able to monitor their comprehension, but take longer to do so than peers who do not have epilepsy. For correct responses, both groups took longer to respond following an inconsistent sentence than a consistent sentence within the same passage, indicating that additional processing may be taking place upon the detection of an inconsistency, as has been reported in other studies with typically developing children [19, 36]. Due to the small sample size we were not able to analyse statistically whether current medication status influenced performance in this task. However, an examination of means (see Tables S3-S5, supplementary materials) indicates that differences between the CECTS and comparison groups were greater for the subsample of CECTS participants in receipt of AEDs than for the CECTS participants who were not. Similarly, we were not able to analyse statistically whether a comorbid diagnosis influenced performance in this task. However an examination of means (see Tables S9-S11, supplementary materials) indicates that differences between the CECTS and comparison groups were smaller for the subset of CECTS participants with a comorbid diagnosis than for the CECTS participants without comorbid diagnosis.

3. Experiment 2: Inference Generation

3.1. Introduction

The inference task comprised a set of short narrative passages in which an inference was required to integrate the meanings of two sentences. After each passage, participants responded to a question to evaluate whether or not they had made the target inference. Such tasks are sensitive to individual differences in inference making in our target age range [41, 42]. We also manipulated the distance between the two critical sentences. As for the coherence monitoring task, increasing the distance between pieces of information to be integrated, increases the difficulty of inference generation [11, 37, 43]. As for the comprehension monitoring task, if participants with CECTS have difficulties with text integration, they should perform more poorly on this task than the comparison group who did not have epilepsy. If their difficulties impact on their overall quality of understanding, we should observe lower question answering accuracy. If they have impaired access to the target information in the mental model they have constructed while listening to the text, we should observe slower response times to questions. If their difficulties arise at the time of integration, we should observe longer processing times for sentences as they are presented.

3.2. Method

3.2.1. Participants

See Table 1.

3.2.2. Measures and procedure

Each child listened to 16 six-sentence narrative passages. As for the coherence monitoring task, participants listened to each sentence and pushed a button on a response box to hear the next sentence. The processing load for was manipulated by placing the two critical sentences either adjacent to each other (near condition, low processing demands) or two sentences apart (far condition, high processing demands). There were 8 items in each condition and examples are provided in Table 6. The items were counterbalanced across two presentation lists and each participant read only one version of each passage.

After each passage, participants answered a yes/no question to assess whether or not they had generated the target inference. The correct response was yes for half of the items. Two practice items with feedback were completed before the experimental items. There were three outcome variables: (a) accuracy to the inference question in the near and far conditions; (b) response time to the inference question in the near and far conditions; and (c) processing time for the critical sentences within the texts in the near and far conditions.

Table 6

Example materials

Near

1. Helen liked to read stories.
2. Helen was looking forward to reading her favourite book after school.
3. Helen's favourite book was about a princess.
4. **Helen had a naughty dog that liked to chew things.**
5. **When Helen got home she found some of the pages of her favourite story book on the kitchen floor.**
6. Helen had lots of books.

INFERENCE QUESTION: Did Helen's dog chew her favourite story book to pieces? YES

Near

1. Kate's favourite sport was swimming.
2. On Monday night, Kate was taking part in a swimming race.
3. The swimming pool was near Kate's house.
4. **On Monday Kate was very sick.**
5. **The next day at school, Kate's friends told her who won the race.**
6. The girls then chatted about their dance class.

INFERENCE QUESTION: Did Kate swim in the race? No

In the far condition, sentences 2 and 3 were inserted between sentences 4 and 5, so the order was: 1, 4, 2, 3, 5, and 6.

3.3. Results

3.3.1. Inference question accuracy

The mean proportions of correct responses to the inference question are reported in Table 7. Only responses after the question had been heard in its entirety are included because the questions differed for each passage and could not accurately be anticipated[4]. All participants contributed at least 8/16 data points to these means. The means indicate

[4] Excluding question responses before the end of the question resulted in 4.34% data loss (3.55% of question responses for comparison children and 5.68% of question responses for children with CECTS).

that the children with CECTS were less likely to provide an accurate response than the comparison group and that performance was comparable for the near and far conditions, overall.

Table 7

Mean proportion of correct responses (and standard deviations) to the inference question

	Group						
	Comparison			CECTS			Total
Condition	M	Min	Max	M	Min	Max	
Near	0.77 (0.42)	0.14	1.00	0.76 (0.43)	0.33	1.00	0.77 (0.42)
Far	0.81 (0.40)	0.25	1.00	0.75 (0.44)	0.13	1.00	0.78 (0.41)
Total	0.79 (0.41)			0.75 (0.43)			

We fitted a GLMM to estimate the effects of group, condition, and the interaction between these factors, influencing the log odds that a child's response to the inference question would be correct. As in our analysis of the coherence monitoring sense question data, our model included random effects corresponding to by-participants deviations in intercepts and in the effect of condition and by-items deviations in intercepts. The model summary is reported in the Appendix (Table A6). In general, participants were more likely to answer the inference question correctly than incorrectly. This is shown by the significant positive value for the intercept (B = 1.62, SE = 0.27, z = 5.92, p <.01). The two groups did not differ in question response accuracy (B = 0.12, SE = 0.16, z = 0.77, p = .44) and the distance manipulation did not influence performance (condition B = -0.12, SE = 0.11, z = -1.11, p = .27; group x condition B = -0.07, SE = 0.10, z = -0.70, p = .48).

3.3.2. Inference question response times for correct responses

Inference question response times for correctly answered questions are reported in Table 8. As above, only response times after the question had been heard in its entirety are included[5]. The means indicate that children with CECTS took longer to respond to the question than those in the comparison group and that, in general, responses were longer when the critical sentences were adjacent (near condition) compared to separated (far condition). However the standard deviations indicate substantial variation in response times, particularly for children with CECTS.

The data were analysed using linear mixed-effects models. The models included the same fixed effects, interactions, and random intercepts as included in the question accuracy model, but the random slopes differed; only slopes to control for between-text differences in the effect of group were included. The final model summary is reported in the Appendix Table A7.

Table 8

Mean response times for the inference question (and standard deviations) in ms: Correct responses

	Group		
Condition	Comparison	CECTS	Total
Near	1666.30 (2379.05)	3191.66 (5769.69)	2223.39 (4027.92)
Far	1800.19 (2542.49)	2040.30 (2984.44)	1883.82 (2702.87)
Total	1735.18 (2462.66)	2620.58 (4630.77)	

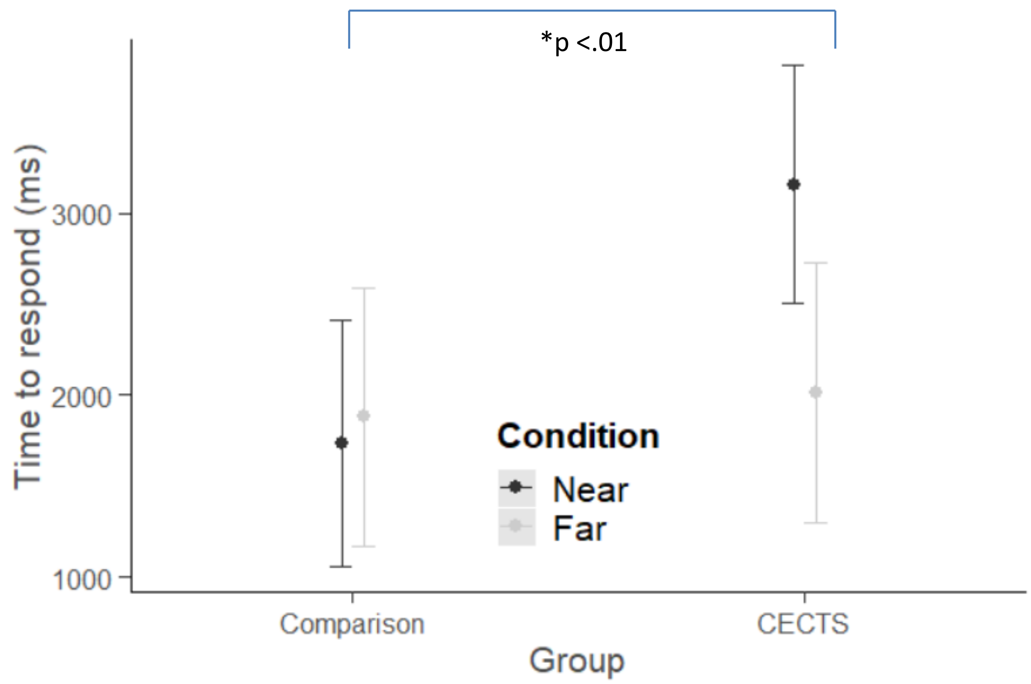
Despite the substantial difference in means, the main effect of group did not reach statistical significance: Children with CECTS were not reliably slower to respond than the comparison group overall (*B* = -389.60, *SE* = 253.09, *z* = -1.54, *p* = .13). There was a significant main effect of condition: Participants took longer to respond to the inference question when the two sentences that enabled the inference were adjacent (near condition), compared to when they were separated (far condition) (*B* = 249.24, *SE* = 114.43,

[5] Excluding question response times before the end of question, for questions answered correctly, resulted in 3.84% data loss (3.01% of response times for comparison children and 5.30% of response times for children with CECTS).

z = 2.16, *p* = .03). This main effect was qualified by a significant interaction between group and condition (*B* = -322.78, *SE* = 115.52, *z* = -2.79, *p* <.01). Examination of the interaction plot (Figure 2) shows that only participants with CECTS were influenced by the distance manipulation: They were slower to respond when sentences were adjacent compared to when separated. When the data was subset by group, the much larger *B* coefficient and *t* values for children with CECTS confirmed this interpretation: *B* = 594.67, *SE* = 246.78, *t* = 2.41; *B* = -70.71, *SE* = 106.07, *t* = -0.67 respectively (see Appendix Tables A8 and A9).

Figure 2

Inference question response times (with standard error): correct responses, Group x Condition interaction



3.3.3. Sentence processing times

We compared the processing time of each inference prompting sentence (sentence 5) in the near and far conditions with the time for the premise sentence, which was sentence 2 in the far condition and sentence 4 in the near condition. As for the coherence monitoring sentence analysis, this analysis was performed only for items for which participants had made a correct response to the inference-tapping question (just over 75% of all items). As before, sentence processing time was recorded as the time to push the button to hear the next sentence after the current sentence had been heard in its entirety[6]. All times were within +/-3 SDs of an individual's condition mean. Sentence processing times for correct inference question responses are reported in Table 9. The means indicate that children with CECTS responded more slowly following the sentences than the comparison group. As for question response times, the standard deviations indicate considerable variation in speed, particularly for the group with CECTS.

Table 9

Premise and inference prompting sentence response times (and standard deviations) in each condition (ms): Correct responses

			Group		
Response	Condition	Sentence Type	Comparison	CECTS	Total
Correct	Near	Premise	681.66 (642.66)	960.36 (1299.42)	782.09 (941.75)
	Near	Inference-prompting	705.05 (652.06)	1031.25 (1637.28)	823.49 (1126.95)
	Far	Premise	770.65 (1602.28)	1044.10 (1840.55)	859.88 (1685.82)
	Far	Inference-prompting	716.07 (552.12)	1017.90 (1869.81)	818.16 (1182.20)
Total			718.91 (967.01)	1012.64 (1665.32)	

[6] Excluding sentence response times before the end of the sentence, for questions answered correctly, resulted in 4.42% data loss (2.99% of sentence response times for comparison children and 7.00% of response times for children with CECTS).

Sentence processing times for the premise sentence and the inference-prompting sentence were analysed using LMMs. The model included the same fixed effects, interactions, and random intercepts as previous models, with the addition of sentence type (premise, inference) as a fixed effect. The final model summary is reported in Appendix Table A10. The children with CECTS took substantially longer to press the button for the next sentence than the comparison group (B = -163.89, SE = 84.65, t = -1.94), but there was substantial variability in the data and the effect did not reach statistical significance (p = .06). No other main effects or interactions approached significance.

3.4. Discussion

Children with CECTS were not significantly less accurate than age matched comparison children to respond to a question requiring the generation of an inference from two sentences in a short narrative. Differences between groups were apparent in the time taken to complete the task. For correct responses, children with CECTS were slower to respond to the question than the comparison group. However, this group effect was only significant when the sentences to be integrated were adjacent. Similarly, children with CECTS were slower to process the critical sentences within the texts but this difference did not reach statistical significance. This pattern of findings suggests that children with CECTS are able to generate inferences, but take longer to do so than peers who do not have epilepsy. As for the previous task, due to the small sample size we were not able to analyse statistically whether current medication status influenced performance in this task. However, an examination of means (see Tables S6-S8, supplementary materials) indicates that consistent with the previous task, differences between the CECTS and comparison groups were greater for the subsample of CECTS participants in receipt of AEDs than for the CECTS participants who were not. Similarly, we were not able to analyse statistically whether a comorbid diagnosis influenced performance in this task. However an examination of means (see Tables S12-S14, supplementary materials) indicates that differences between the CECTS and comparison groups were smaller for the subset of CECTS participants with a comorbid diagnosis than for the CECTS participants without one.

4. General Discussion

4.1. Summary of findings

Across two independent tasks to examine text integration, we found that children with CECTS performed similarly to a comparison group without epilepsy to answer questions that assessed their ability to integrate sentences within short narrative passages, however group differences in the time taken to do so were evident. These findings are robust, being observed across two experiments with different materials and different task requirements. These findings are noteworthy because the text integration skills assessed in this study, coherence monitoring and inference generation, are key to good reading and listening comprehension [12, 22, 24, 44, 45]. Children with CECTS are known to be at increased risk of listening and reading comprehension weaknesses [9]. These findings demonstrate that children with CECTS perform at a similar level to a comparison group on tasks that assess these critical text integration comprehension skills, but require more time to do so. This pattern of findings concurs with reports of low achievement in children with epilepsy [46] and provides valuable insights into educational support to minimise educational impacts.

4.2. Quality of the product of text comprehension: question answering accuracy

The quality of text comprehension is typically assessed by question answering accuracy, which taps the quality of the mental model – the representation of meaning constructed as the text is presented. Overall question answering accuracy was comparable between groups across tasks for children with CECTS but, in our coherence monitoring task, we found a group difference in the effect of increased processing load. As predicted, increased processing load in the coherence monitoring task was related to decreased question accuracy for the comparison children [19, 36] with their resultant performance in line with the group with CECTS. Processing load did not have a detrimental effect on the performance of the children with CECTS suggesting that children with CECTS were less influenced by processing load than the comparison group.

A possible explanation for this observation comes from the relationship between working memory and text integration that is found in children in this age range who do not have epilepsy [42]. Working memory difficulties have been noted in some children with CECTS (e.g., [47, 48]). The children with epilepsy may have failed to gain an advantage for detecting inconsistencies when the processing load was low if their working memory capacity was insufficient to reliably support integration of information even when presented in adjacent sentences. Future research should examine this explanation.

In contrast to the coherence monitoring task, there was no effect of processing load on the question accuracy responses in the inference generation task. This difference between tasks may be related to the sensitivity of our yes/no decision task. Previous research with typically developing children, which has found a decrease in inference generation accuracy with processing load, has typically used open ended questions with verbal responses [11, 43]. Our choice of methodology enabled us to capture response time data, but may have been less sensitive to the effect of processing load on response accuracy in the inference generation task. Future work is needed to determine the most reliable, valid, and sensitive measure(s) of the product of text integration processes to support reliable diagnostic tools to assess the quality of children's text comprehension.

We note the relative strength of performance – in terms of question answering accuracy - demonstrated by children with CECTS on both tasks when assessed with auditory delivery. These findings indicate that auditory presentation of information during the delivery of learning material and/or assessment may be more suitable for children with CECTS than assessments that require reading. This conclusion is supported by calls to assess listening comprehension, alongside word reading and reading comprehension, to accurately identify the source and effective target for intervention in apparent reading comprehension difficulties [49]. Children whose poor reading comprehension is the result of poor word reading, require different intervention to those whose poor reading comprehension arises due to language and text integration difficulties [49].

4.3. Efficiency of text integration processes: question answering response time and sentence processing time

A particular strength of our study is that we examined not only the product of comprehension in our two groups with question accuracy, but also the *efficiency* of the processes involved in construction of, and access to, this product of text comprehension. We found insightful and important group differences. Children with CECTS took longer than the comparison group to respond to questions in both tasks: They took longer to make accurate responses to coherence monitoring sense questions overall, and to inference questions (difference statistically significant only for near condition). They also took longer to process critical sentences during the auditory presentation of text, sentence by sentence, in both tasks. These findings suggest that the children with CECTS needed more time than the children in the comparison group to locate and retrieve information from their mental model of a text in order to answer the questions after each passage. They also needed more time to integrate successive pieces of information into their unfolding mental model, during auditory presentation.

These findings should be considered in relation to other work on text comprehension in this population. For example, children with CECTS are less accurate and also slower than peers to evaluate whether the content of two sentences are coherent or not, but non-signficant group differences indicate that they perform within the range of performance seen in non-typical populations [50]. Together, with our work, this suggests that children with CECTS show adequate sentence and passage comprehension in certain contexts. Of note, fMRI scans indicate the recruitment of additional, perhaps compensatory, areas of the brain in the children with CECTS [50] and altered connectivity between language areas, which may underlie these processing weaknesses [51]. Those findings align our observation that children with CECTS required more time to achieve performance in line with that of peers.

Together, these findings suggest that children with CECTS may be at a disadvantage in the everyday classroom, as well as on critical timed assessments in the form of diagnostic cognitive tests and national school-based educational assessments and qualification examinations. Subtle differences in processing speed may have a downstream effect of insufficient cognitive resource to process each new piece of information, as the text unfolds, in time limited situations. Our method of self-paced auditory presentation is different to typical classroom auditory delivery, where students are not able to control the presentation rate of an assessor or classroom teacher. Thus, auditory presentation *per se* may not always be optimal for this group. Further research is needed to specify the optimal conditions for school-based reading and listening to support effective learning in this population. Further, educational diagnostic assessment should include a comprehensive range of presentation conditions (visual, auditory; timed, untimed, self-paced) to inform classroom support, suitable adjustments, and intervention. Our finding of comparable accuracy to age-matched peers also suggest that interventions that target processing efficiency may be more beneficial than those focusing on teaching the strategy itself.

4.4. Variability in the data and its implications

We found considerable variability in performance in our CECTS sample, which aligns with the variability found in other clinical populations [52]. There are several points that warrant further consideration. First, although our sample was similar or larger to that in many other studies in the field [53, 54], it was not sufficient to reliably examine whether current medication status or a comorbid diagnosis influenced performance. An examination of means indicated that the subsample of CECTS participants taking medication may have had poorer performance. In contrast, there was no evidence that children in the CECTS group with a comorbid diagnosis had worse performance indicating that any weaknesses in the CECTS group were not the result of comorbid learning difficulties. Second, this variability indicates that careful consideration needs to be given to identifying the specific skills and difficulties of individual children with this diagnosis. In addition to the cognitive skills we have examined, consideration to the influence of psychomotor processing is required, due to the documented weaknesses for this population [53, 55, 56]. As already noted, children with CECTS often experience difficulties with measures of complex working memory [47, 48], performance on which is associated with integrative processing in the reading and listening comprehension literature [23]. However, a recent systematic review demonstrates heterogeneity in findings [30]: Children with CECTS do not consistently perform at a lower level than comparison groups on working memory tasks. Thus, there are potentially myriad factors that may underlie the variability found in processing speed in our sample of children with CECTS. Robust educational interventions require identification of the relative influence of each.

4.5. Task considerations

We assessed children's coherence monitoring and inference skills using listening tasks to mitigate the known risk of word reading difficulties in the CECTS population and provide assessments that would be accessible to a broad age range. Our findings indicate strong performance, but it remains possible that children with CECTS would be disadvantaged in coherence monitoring and inference generation tasks compared to a comparison group when reading is required, given their noted word reading difficulties [2]. It is also important to note that our participants were required only to provide a yes/no button press response. Future research should investigate whether children with CECTS are disadvantaged compared to a comparison group when they are required to produce a verbal response explaining the inconsistencies or generating inferences.

4.6. Conclusions

Our study is the first to examine critical text integration skills - coherence monitoring and inference generation - in children with CECTS. We used a sentence-by-sentence listening comprehension paradigm to mitigate for word reading differences in our sample and to enable participants to control delivery rate. We found that, when assessed in this way, children with CECTS are as accurate as their age matched peers in the quality of their comprehension; they achieve the same levels of comprehension accuracy across different tasks. However, the data show that the children with CECTS require more time to achieve this same level of performance.

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Appendix

Table A1

Summary GLMM for sense question accuracy (log odds)

Fixed effects	Estimated coefficient (*β*)	*SE*	*z*	*p*
(Intercept)	1.34	0.17	7.68	<.001
Group (Comparison)	0.15	0.12	1.24	.21
Condition (Near)	0.16	0.14	1.11	.27
Condition (Far)	**-0.29**	**0.14**	**-2.14**	**.03**
Group x Condition (Near)	0.20	0.11	1.76	.08
Group x Condition (Far)	**-0.26**	**0.11**	**-2.38**	**.02**
Random effects			Variance	SD
Participant	(intercept)		0.96	0.98
	Condition		1.44	1.20
Text	(intercept)		0.33	0.58
R^2marginal[a] = 0.03, R^2marginal[b] = 0.30				

Note. Observations = 1464, Participants = 61, Texts = 24. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. Effects in bold are statistically significant. All categorical fixed effects were contrast coded in order to be able to interpret the lower order (main) effects. Group: Comparison = +1, CECTS = -1; Condition: first contrast Inconsistent Near = +1, Inconsistent Far = 0, Consistent = -1; second contrast Inconsistent Near = 0, Inconsistent Far = 1, Consistent = -1.

Table A2

Summary GLMM for sense question accuracy (log odds): Comparison group

Fixed Effects	Estimated Coefficient (*β*)	SE	z	p
(Intercept)	1.52	0.22	7.07	<.01
Condition (Near)	**0.38**	**0.18**	**2.08**	**.04**
Condition (Far)	**-0.56**	**0.17**	**-3.26**	**<.01**
Random Effects			Variance	SD
Participant	(Intercept)		1.01	1.00
	Condition		1.58	1.26
Text	(Intercept)		0.50	0.71
R^2marginal[a] = 0.03, R^2marginal[b] = 0.32				

Note. Observations = 912, Participants = 38, Texts = 24. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. Effects in bold are statistically significant.

Table A3

Summary GLMM for sense question accuracy (log odds): CECTS group

Fixed Effects		Estimated Coefficient (*β*)	*SE*	*z*	*p*
(Intercept)		1.15	0.21	5.38	<.01
Condition (Near)		-0.07	0.17	-0.39	.70
Condition (Far)		-0.07	0.17	-0.39	.70
Random Effects				Variance	SD
Participant	(Intercept)			0.88	0.94
	Condition			1.34	1.16
Text				0.11	0.32
R^2marginal[a] = 0.002, R^2marginal[b] = 0.24					

Note. Observations = 552, Participants = 23, Texts = 24. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects.

Table A4

Summary LMM for sense question response time (ms): Correct responses

Fixed Effects		Estimated Coefficient (*β*)	*SE*	*t*	*p*
(Intercept)		3281.67	220.97	14.85	<.01
Group (Comparison)		**-512.99**	**213.59**	**-2.40**	**.02**
Condition (Near)		208.73	141.06	1,48	.14
Condition (Far)		-157.52	143.35	-1.01	.27
Group x Condition (Near)		-194.55	135.35	-1.44	.15
Group x Condition (Far)		-53.34	137.68	-0.39	.70
Random Effects				Variance	SD
Participant	(Intercept)			2072545	1439.6
Text	(Intercept)			76111	275.9
R^2marginal[a] = 0.02, R^2marginal[b] = 0.21					

Note. Observations = 1096, Participants = 61, Texts = 24. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. Effects in bold are statistically significant. All categorical fixed effects were contrast coded to order to be able to interpret the lower order (main) effects. Group: Comparison = +1, CECTS = -1; Condition: Inconsistent Near = +1, Inconsistent Far = +1, Consistent –1.

Table A5

Summary LMM for coherence monitoring sentence processing time (ms): Correct responses

CECTS: Text comprehension and integration

Fixed Effects	Estimated Coefficient (β)	*SE*	*t*	*p*
(Intercept)	1034.88	76.37	13.55	<.01
Group (Comparison)	**-145.21**	**70.10**	**-2.07**	**.04**
Condition (Near)	-50.71	34.53	-1.47	.15
Sentence type (Consistent)	**-182.51**	**40.33**	**-4.53**	**<.01**
Group x Condition	24.77	34.53	0.72	.48
Group x Sentence type	-28.93	40.33	-0.72	.48
Condition x Sentence type	29.20	23.82	1.23	.22
Group x Condition x Sentence type	-12.81	23.82	-0.54	.59
Random Effects			Variance	SD
Participant	(intercept)		245396	495.4
	Condition		33561	183.2
	Sentence type		59766	244.5
Text	(intercept)		14494	120.4
R^2marginal[a] = 0.02, R^2marginal[b] = 0.21				

Note. Observations = 1375, Participants = 61, Texts = 16. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. Effects in bold are statistically significant. All categorical fixed effects were contrast coded in order to be able to interpret the lower order (main) effects. Group: Comparison = +1, CECTS = -1; Condition: Near = +1, Far = -1; Sentence type: Consistent = +1, Inconsistent = -1.

Table A6

Summary GLMM for (log odds) inference question accuracy

Fixed effects	Estimated coefficient (β)	*SE*	*z*	*p*
(Intercept)	1.62	0.27	5.92	<.01
Group (Comparison)	0.12	0.16	0.77	.44
Condition (Near)	-0.12	0.11	-1.11	.27
Group x Condition	-0.07	0.10	-0.70	.48
Random effects			Variance	SD
Partcipant	(intercept)		0.93	0.96
	Condition		0.09	0.30
Text	(intercept)		0.73	0.85
R^2marginal[a] = 0.01, R^2marginal[b] = 0.35				

Note. Observations = 903, Participants = 59, Texts = 16. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. All categorical fixed effects were contrast coded to order to be able to interpret the lower order (main) effects. Group: Comparison = +1, CECTS = -1; Condition: Near = +1, Far = -1.

Table A7

Summary LMM for inference question response time (ms): Correct responses

Fixed Effects		Estimated Coefficient (*β*)	*SE*	*t*	*p*
(Intercept)		2196.30	344.95	6.37	<.01
Group (Comparison)		-389.60	253.09	-1.54	.13
Condition (Near)		**249.24**	**115.43**	**2.16**	**.03**
Group x Condition		**-322.78**	**115.52**	**-2.79**	**<.01**
Random Effects				Variance	SD
Participant	(Intercept)			2231927	1494
Text	(Intercept)			1028023	1014
	Group			152893	391
R^2marginal[a] = 0.02, R^2marginal[b] = 0.29					

Note. Observations = 701, Participants = 59, Texts = 16. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. Effects in bold are statistically significant. All categorical fixed effects were contrast coded to order to be able to interpret the lower order (main) effects. Group: Comparison = +1, CECTS = -1; Condition: Near = +1, Far = -1.

Table A8

Summary LMM for inference question response time (ms): CECTS

Fixed Effects		Estimated Coefficient (*β*)	*SE*	*z*	*p*
(Intercept)		2532.63	608.63	4.16	<.01
Condition		594.67	246.78	2.41	<.01
Random Effects				Variance	SD
Participant	(Intercept)			4907387	2215
Text	(Intercept)			1303677	1142
R^2marginal[a] = .017, R^2marginal[b] = .31					

Note. Observations = 250, Participants = 22, Texts = 16. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. Effects in bold are statistically significant.

Table A9

Summary LMM for inference question response time (ms): TD

CECTS: Text comprehension and integration

Fixed Effects	Estimated Coefficient (*β*)	*SE*	*z*	*p*
(Intercept)	1812.83	260.81	6.95	<.01
Condition	-70.71	106.07	-0.67	0.51
Random Effects			Variance	SD
Participant	(Intercept)		724493	851.2
Text	(Intercept)		588812	767.3
R^2marginal[a] =.0008 , R^2marginal[b] = .21				

Note. Observations = 451, Participants = 37, Texts = 16. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. Effects in bold are statistically significant.

Table A10

Summary LMM for sentence response times: Correct responses

Fixed Effects	Estimated Coefficient (*β*)	*SE*	*t*	*p*
(Intercept)	885.11	90.82	9.75	<.01
Group (Comparison)	-163.89	84.65	-1.94	.06
Condition (Near)	-8.41	32.22	-0.26	.79
Sentence (Premise)	-0.48	31.86	-0.02	.99
Group x Condition	-13.56	32.21	-0.42	.67
Group x Sentence type	9.24	31.86	-0.29	.77
Condition x Sentence type	-22.23	31.85	-0.70	.49
Group x Condition x Sentence type	0.70	31.85	0.02	.98
Random Effects			Variance	SD
Participant	(Intercept)		333592	577.6
Text	(Intercept)		16977	130.3
R^2marginal[a] = 0.02, R^2marginal[b] = 0.23				

Note. Observations = 1340, Participants = 59, Texts = 16. R^2 calcualted using the MuMIn package in R, [a]represents the variance explained by the fixed effects, [b]represents the variance explained by the entire model including both fixed and random effects. All categorical fixed effects were contrast coded to order to be able to interpret the lower order (main) effects. Group: Comparison = +1, CECTS = -1; Condition: Near = +1, Far = -1, Sentence: Premise = +1, Inference = -1