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Examining Response Time and Accuracy in Jumbled Procedure Text Tasks Through Speed–Accuracy Trade-Off Theory

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Abstract

Response time is often overlooked in EFL reading assessment, despite its potential to reveal students' cognitive processing. This research examines seventh-grade students' response time and accuracy in completing a jumbled procedure text task based on the Speed–Accuracy Trade-Off (SAT) theory. Using a quantitative descriptive design, the research involved students from a junior high school in Indonesia. Data were collected through a digital task administered via Wordwall, measuring both accuracy and response time. The findings indicate considerable variation in students' performance, suggesting that learners employ different response strategies when completing the task. While a majority of students demonstrated patterns consistent with the classic speed–accuracy trade-off, a substantial proportion showed non-trade-off patterns, indicating that speed and accuracy do not always operate inversely in classroom-based language tasks. Furthermore, the relationship between response time and accuracy was found to be weak, implying that accuracy alone cannot adequately explain students' response behavior. These results highlight the importance of integrating response time as a complementary indicator in reading assessment. By considering both speed and accuracy, teachers can gain a more comprehensive understanding of students' cognitive processing and design more effective instructional strategies.

Keywords: Response Time; Accuracy; Jumbled Procedure Text; Speed–Accuracy Trade-Off Theory; EFL Students

INTRODUCTION

Reading comprehension is a fundamental component of English as a Foreign Language (EFL) learning, particularly in understanding structured texts such as procedure texts that require sequential, logical, and goal-oriented processing (Grabe and Yamashita, 2022). Recent studies also emphasize that reading comprehension involves strategic meaning construction rather than passive decoding. Comprehension is not merely the ability to decode linguistic forms, but also involves constructing meaning through the integration of vocabulary knowledge, syntactic awareness, and prior knowledge (Snow, 2002). This view is supported by research highlighting the role of linguistic and cognitive integration in reading processes (Koda, 2012). In the Indonesian educational context, procedure texts are introduced at the junior high school level as part of the national curriculum to develop students' ability to interpret instructions and organize information systematically (Kementerian Pendidikan dan Kebudayaan, 2022). Empirical classroom studies further show that structured texts support functional literacy development among EFL learners. Therefore, reading comprehension should be viewed not only as a linguistic competence but also as a complex cognitive activity requiring active engagement and interpretation (Nuttall, 1996).

Despite its importance, many EFL learners still experience difficulties in comprehending texts effectively. These challenges are often related to limited vocabulary mastery, insufficient background knowledge, and difficulties in processing textual information (Mahmood, 2022). Vocabulary limitation has consistently been identified as a major barrier in EFL reading. At the junior high school level, students are still developing their cognitive and linguistic abilities,

which influences how they process procedural texts (Slavin, 2018). Recent studies also indicate that learners at this stage are still refining their reading strategies (Vongsawath et al., 2025). Consequently, students' performance may vary significantly, reflecting differences in both knowledge and cognitive processing strategies (Safitri, 2023).

In classroom practice, reading comprehension is commonly assessed through tasks that emphasize accuracy as the primary indicator of performance (Brown, 2004). Outcome-based assessment remains dominant in EFL contexts (Perkasa, 2021). However, accuracy alone may not fully represent students' comprehension processes, as it does not capture how students arrive at their answers (Eslami, 2023). Recent studies highlight that accuracy cannot fully reflect students' cognitive engagement during task completion (Du & Ma, 2021). As a result, important aspects such as response strategies and processing efficiency remain underexplored (Goldhammer et al., 2021). The variability of students' response behavior further demonstrates the limitations of accuracy-based assessment. Some students respond quickly but inaccurately, while others take longer yet still fail to achieve correct answers. There are also students who demonstrate both speed and accuracy, indicating higher levels of fluency and mastery. These variations suggest that performance is influenced not only by knowledge but also by how students manage their cognitive resources (Boeck and Jeon, 2019). This aligns with cognitive load theory, which emphasizes the role of limited processing capacity in task performance (Sweller, 1988). Recent research also supports this perspective by highlighting the importance of efficient cognitive resource management (Chen et al., 2021).

In this regard, response time has been increasingly recognized as an important indicator in educational assessment. Response time refers to the duration required by individuals to process information, make decisions, and produce responses (White and Kitchen, 2022). In learning contexts, response time provides insight into students' cognitive processing, including their fluency, hesitation, and level of certainty. Faster response times are often associated with automatic processing and well-developed knowledge structures, while longer response times may indicate uncertainty, confusion, or increased cognitive effort (Heitz, 2014). Therefore, incorporating response time alongside accuracy can provide a more comprehensive understanding of students' performance as it captures both the outcomes and the processes of task completion (Tan & Bulut, 2025).

The relationship between response time and accuracy is explained by the Speed–Accuracy Trade-Off (SAT) theory, which suggests that individuals balance speed and accuracy under cognitive constraints (Wickelgren, 1977). Recent studies confirm that this relationship is influenced by task conditions and is not always linear (Alfers et al., 2025). In some cases, longer response time does not lead to higher accuracy, indicating that extended processing may reflect confusion rather than careful reasoning (Liang, 2024). Similar findings have been reported in real-world educational settings (Domingue et al., 2022). These findings indicate that students' performance should be interpreted through patterns of behavior rather than simple statistical relationships.

In language learning contexts, tasks involving higher-order cognitive processing are particularly suitable for examining this relationship. One such task is the jumbled procedure text task, which requires students to arrange disordered sentences into a coherent sequence (Aulia, 2023). This task involves syntactic analysis, coherence understanding, and logical reasoning. Procedure texts also have specific structural characteristics that must be followed to

achieve coherence (Derewianka & Jones, 2016). Therefore, this task provides a suitable context for observing students' response strategies.

The cognitive demands of jumbled tasks may lead students to adopt different strategies. Some may respond quickly based on intuition, resulting in lower accuracy, while others may take more time to analyze the text structure, which may or may not improve accuracy. There are also students who demonstrate both speed and accuracy, indicating efficient cognitive processing (Prakash and Heckler, 2025). These variations highlight the importance of examining not only correctness but also how responses are produced (Wang and Chen, 2020).
However, in the Indonesian EFL context, research on jumbled tasks has primarily focused on learning outcomes rather than response processes (Riska, 2023). Similar findings are also reported in classroom-based instructional studies (Patty and Wardani, 2025). Although these studies demonstrate the effectiveness of jumbled tasks in improving students' comprehension and engagement, they do not examine how students manage response time and accuracy during task completion. Consequently, there is still limited understanding of students' cognitive response behavior in EFL reading tasks (Pahrizal, 2024). To address this gap, the present research integrates response time and accuracy to identify students' performance patterns based on the principles of the Speed–Accuracy Trade-Off (SAT) theory. Unlike previous studies that primarily emphasized learning outcomes, this research focuses on categorizing students into fast–accurate, fast–inaccurate, slow–accurate, and slow–inaccurate groups to provide a more process-oriented interpretation of students' reading performance.

To address this gap, the present research aims to provide a more comprehensive understanding of students' performance by examining both response time and accuracy in completing a jumbled procedure text task. Unlike previous studies that predominantly focus on learning outcomes, this research emphasizes performance patterns by categorizing students into fast–accurate, fast–inaccurate, slow–accurate, and slow–inaccurate groups. These categories are used to interpret how students regulate their response behavior in relation to the principles of the Speed–Accuracy Trade-Off (SAT) theory. Therefore, the novelty of this research lies in its integration of response time and accuracy as complementary indicators and its focus on performance categorization rather than solely outcome-based measurement.

This research employs a descriptive quantitative approach to examine students' performance patterns. The findings are expected to contribute theoretically by extending the application of SAT theory in EFL assessment contexts, particularly at the junior high school level. In addition, this research provides practical implications for teachers by offering a more nuanced way to interpret students' performance, taking into account not only correctness but also response time and performance categories. Ultimately, this research aims to promote more comprehensive and process-oriented assessment practices in language learning by integrating both accuracy and response time as essential indicators of students' performance.

METHOD

This research employed a quantitative descriptive non-experimental design to describe students' response time and accuracy in completing a jumbled procedure text task and to identify their performance categories based on the Speed–Accuracy Trade-Off (SAT) theory (Creswell, 2014). The research was conducted at SMP Negeri 4 Pekalongan, Indonesia, involving seventh-grade students. One intact class (VII B) consisting of 32 students was selected using convenience sampling based on accessibility and classroom feasibility.

The instrument used was a jumbled procedure text task entitled *"How to Make Strawberry Banana Smoothie,"* which required students to arrange ten disordered sentences into a correct and logical sequence. Students' accuracy was measured based on the correctness of their answers with a maximum score of 10, while response time was recorded in seconds using the Wordwall platform, starting from the moment students began reading and working on the task until they submitted their final answers. The instrument was validated through expert judgment by an English teacher of seventh grade at SMP Negeri 4 Pekalongan to ensure content relevance, clarity, and appropriate language level. Data were collected in a single session under controlled classroom conditions, where students completed the task individually.

The data were analyzed using descriptive statistics, including mean, standard deviation, minimum, and maximum scores. Furthermore, students' performance was operationally classified into four descriptive categories: fast–accurate, fast–inaccurate, slow–accurate, and slow–inaccurate, based on the mean values of response time and accuracy. This categorization was adapted from response time and accuracy frameworks proposed by Coomans et al. (2016), which distinguish performance patterns based on combinations of response speed and correctness, and was interpreted through the principles of the Speed–Accuracy Trade-Off theory. A scatter plot was also used to visualize the distribution of students' performance patterns.

RESULTS AND DISCUSSION

Results

This section presents the findings of the research regarding response time and accuracy in completing a jumbled procedure text task. The data were obtained from 32 students of class VII B at SMP Negeri 4 Pekalongan. The jumbled procedure text task consisted of ten sentences which students had to rearrange into a correct sequence. Accuracy was measured based on the number of correct answers (maximum score = 10), while response time was recorded in seconds using the Wordwall platform. The complete individual data are presented in Table 1.

Table 1. Individual Students' Accuracy and Response Time (N=32)

No	Students Code	Accuracy (score)	Response Time (seconds)	Category
1	A-1	4	80	Fast–Inaccurate
2	A-2	6	215	Slow–Inaccurate
3	A-3	3	144	Fast–Inaccurate
4	A-4	4	158	Fast–Inaccurate
5	A-5	10	255	Slow–Accurate
6	A-6	10	262	Slow–Accurate
7	A-7	10	136	Fast–Accurate
8	A-8	5	268	Slow–Inaccurate
9	A-9	10	207	Slow–Accurate
10	A-10	4	274	Slow–Inaccurate
11	A-11	1	128	Fast–Inaccurate
12	A-12	10	155	Fast–Accurate
13	A-13	8	100	Fast–Accurate
14	A-14	8	255	Slow–Accurate
15	A-15	7	172	Slow–Accurate
16	A-16	4	101	Fast–Inaccurate
17	A-17	7	141	Fast–Accurate

18	A-18	3	123	Fast–Inaccurate
19	A-19	10	182	Slow–Accurate
20	A-20	10	210	Slow–Accurate
21	A-21	7	148	Fast–Accurate
22	A-22	7	80	Fast–Accurate
23	A-23	3	58	Fast–Inaccurate
24	A-24	2	59	Fast–Inaccurate
25	A-25	10	86	Fast–Accurate
26	A-26	8	83	Fast–Accurate
27	A-27	1	251	Slow–Inaccurate
28	A-28	10	214	Slow–Accurate
29	A-29	4	66	Fast–Inaccurate
30	A-30	5	339	Slow–Inaccurate
31	A-31	8	178	Slow–Accurate
32	A-32	10	300	Slow–Accurate

Descriptive Statistics of Response Time and Accuracy

Based on the individual data in Table 1, descriptive statistics were calculated to summarize students' overall performance. Table 2 presents the mean, median, standard deviation (SD), minimum, and maximum scores for both accuracy and response time.

Table 2. Descriptive Statistics of Response Time and Accuracy (N=32)

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
Accuracy (score)	6.53	7.00	2.98	1	10
Response Time (seconds)	169.63	156.50	76.27	58	339

The mean accuracy score was 6.53 (SD = 2.98), indicating that on average students correctly arranged approximately six to seven out of ten sentences. The accuracy scores ranged from 1 to 10, with a median of 7.00, showing wide variation in comprehension. The mean response time was 169.63 seconds (SD = 76.27), with individual times ranging from 58 seconds (fastest) to 339 seconds (slowest). The median response time (156.50 seconds) was slightly lower than the mean, suggesting a positively skewed distribution where a small number of students took considerably longer time. The wide range in both variables indicates substantial individual differences in how students approached the task.

Classification of Performance Categories Based on SAT Theory

The Speed–Accuracy Trade-Off (SAT) theory (Wickelgren, 1977; Heitz, 2014) describes an inverse relationship between speed and accuracy: faster responses tend to be less accurate (fast–inaccurate), and slower responses tend to be more accurate (slow–accurate). However, some individuals may deviate from this pattern, achieving both fast and accurate responses (fast–accurate) or slow but inaccurate responses (slow–inaccurate).

Using the mean values as cut-off points (mean accuracy = 6.53; mean response time = 169.63 seconds), students were classified into four categories. Table 3 presents the distribution.

Table 3. Distribution of Students' Performance Categories (N=32)

Category	Number of Students	Percentage (%)
Fast–Accurate	8	25

Fast–Inaccurate	9	28.1
Slow–Accurate	10	31.2
Slow–Inaccurate	5	15.7

The classic SAT pattern (fast–inaccurate and slow–accurate) was observed in 59.3% of students. The remaining 40.7% deviated: fast–accurate students (25.0%) demonstrated efficient processing without sacrificing accuracy, while slow–inaccurate students (15.7%) took longer time but still performed poorly, suggesting confusion or ineffective strategies (Domingue et al., 2022; Liang, 2024).

Visualization of Performance Patterns

Figure 1 presents a scatter plot of students' accuracy scores (horizontal axis) and response time (vertical axis). Each point represents one student (N = 32). The vertical dashed line indicates the mean accuracy score (6.53), while the horizontal dashed line indicates the mean response time (169.63 seconds). These mean values divide the scatter plot into four quadrants representing the performance categories adapted from the response time and accuracy framework proposed by Coomans et al. (2016), namely fast–accurate, fast–inaccurate, slow–accurate, and slow–inaccurate.

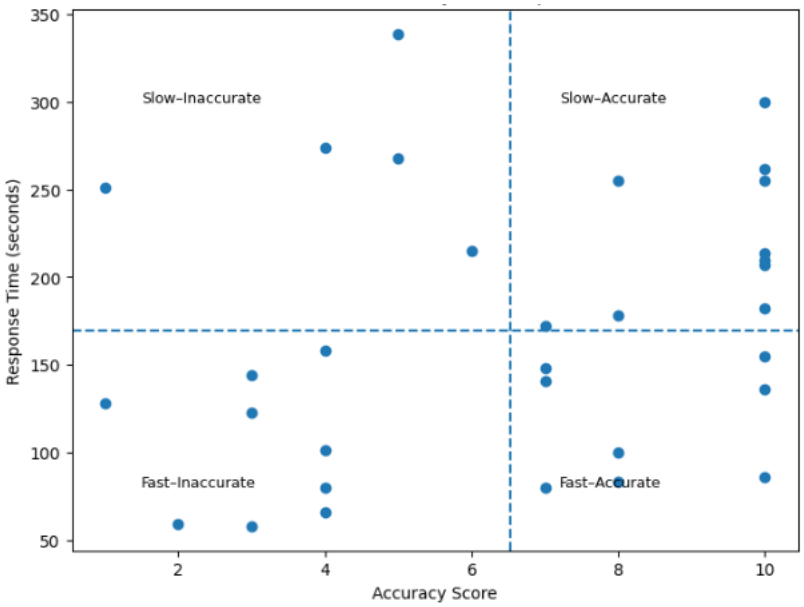

Figure 1. Scatter Plot of Accuracy and Response Time

The scatter plot demonstrates that students' performance patterns were distributed across all four categories, indicating variability in both response speed and accuracy. Several students followed the classic Speed–Accuracy Trade-Off (SAT) pattern by showing either fast–inaccurate or slow–accurate performance. However, a considerable number of students demonstrated non-trade-off patterns, particularly fast–accurate and slow–inaccurate responses. This finding suggests that the relationship between speed and accuracy was not entirely consistent in this classroom-based language task. Students categorized as fast–accurate were able to complete the task efficiently while maintaining high accuracy, which may indicate stronger familiarity with procedure text structure and more efficient cognitive processing. In contrast, students categorized as slow–inaccurate required longer time but still produced low

accuracy, suggesting possible difficulties in comprehension, uncertainty, or ineffective reading strategies during task completion.

The distribution of data points also indicates that accuracy alone cannot fully explain variations in response time. Instead, students' response behavior may have been influenced by multiple factors, such as vocabulary mastery, task familiarity, reading strategies, and cognitive processing differences. These findings support recent studies suggesting that the speed–accuracy relationship is often heterogeneous and task-dependent in educational settings (Domingue et al., 2022; Liang, 2024). Therefore, response time and accuracy should be interpreted together to provide a more comprehensive understanding of students' reading performance in EFL contexts.

Discussion

The findings of this research indicate that seventh-grade EFL students demonstrate considerable variability in performance when completing a jumbled procedure text task. The observed variation in both accuracy and response time suggests that students employ different cognitive and strategic approaches during task completion. The fact that only a portion of students followed the classic speed–accuracy trade-off pattern indicates that the inverse relationship between speed and accuracy is not consistently observed in classroom-based language tasks. This finding supports previous research suggesting that the speed–accuracy relationship is context-dependent and influenced by task characteristics and individual differences (Liang, 2024). The presence of students who demonstrated both high speed and high accuracy challenges the traditional assumption that increased speed necessarily leads to reduced accuracy. These students may possess more efficient cognitive processing, stronger familiarity with procedural text structures, or higher levels of automaticity in reading comprehension. In contrast, the existence of slow–inaccurate students indicates that spending more time on a task does not automatically result in better performance. Longer response time may instead reflect uncertainty, confusion, ineffective reading strategies, or difficulties in organizing textual information. This finding suggests that response time should not always be interpreted as evidence of deeper comprehension, particularly in classroom-based language tasks (Domingue et al., 2022).

Furthermore, the scatter plot visualization demonstrated that students' performance patterns were distributed across multiple categories rather than forming a single consistent trend. This distribution indicates that response time and accuracy should be interpreted together because students may demonstrate different combinations of speed and correctness depending on their cognitive processing strategies, vocabulary knowledge, task familiarity, and reading abilities. Consequently, relying solely on accuracy scores may provide an incomplete interpretation of students' reading performance. From a theoretical perspective, these findings extend the application of the Speed–Accuracy Trade-Off (SAT) theory in EFL assessment contexts by demonstrating that the trade-off pattern is not universally consistent among junior high school learners. From a practical perspective, the findings suggest that teachers should move beyond outcome-oriented assessment practices that focus only on correctness. Integrating response time into classroom assessment may help teachers better identify students' learning needs, cognitive processing patterns, and appropriate instructional support.

CONCLUSION

This research aimed to examine seventh-grade students' response time and accuracy in completing a jumbled procedure text task and to identify their performance patterns based on the Speed–Accuracy Trade-Off (SAT) theory. The findings indicate that students demonstrate considerable variation in performance, reflecting differences in cognitive processing and

response strategies. While some students follow the traditional trade-off between speed and accuracy, others display patterns that deviate from this relationship, suggesting that the interaction between speed and accuracy is not always consistent in classroom-based language tasks. In particular, the coexistence of fast and accurate responses, as well as slow but inaccurate responses, highlights that response time alone does not necessarily determine performance quality. In conclusion, these findings emphasize that assessing reading comprehension solely based on accuracy provides a limited understanding of students' performance. The integration of response time as a complementary indicator offers deeper insight into students' cognitive processing and response behavior. From a theoretical perspective, this research extends the application of SAT theory in EFL contexts by demonstrating that the speed–accuracy relationship is dynamic and influenced by multiple factors. From a practical perspective, the findings encourage teachers to adopt more process-oriented assessment approaches in order to better diagnose students' learning needs and design more targeted instructional strategies. Future research is recommended to explore additional variables, such as vocabulary knowledge, reading strategies, and affective factors, to further explain students' performance patterns.

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