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The importance of understanding learners' cognitive processing of written corrective feedback: Insights from eye-tracking research

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Abstract

Written corrective feedback research in L2 writing has mostly focused on whether feedback improves learners' written work. This type of research shows if learners revise their texts but does not explain how they read and think about feedback while revising. Feedback does not lead to learning on its own. Its value depends on how learners notice, understand, and use it during revision. This reflection paper, using a cognitive perspective and process-based approach, draws on eye-tracking studies to examine learner engagement with WCF. Based on the noticing hypothesis, it discusses how eye tracking can show where students look and for how long, in real-time, when engaging with the input. Research on peer, instructor, automated, and multimodal feedback suggests that students do not attend to all the feedback given equally but choose what to attend to. Patterns of attention differ according to the type of feedback. While immediate feedback enables students to make corrections faster, indirect feedback encourages deeper thinking. This paper also demonstrates how task characteristics, social factors, and learner attitudes influence engagement. Most importantly, it argues that eye-tracking data alone cannot fully explain thought processes, but studies combining eye tracking and think-aloud protocols are better positioned to offer a more comprehensive understanding of feedback processing.

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Introduction

The question of whether feedback helps improve the quality of learners' writing has frequently been the focus of research on written corrective feedback (WCF) in second language (L2) writing. In this type of research, changes in the final written result are typically examined. This method determines if students edit their texts, but it does not explain what goes through their minds when they read and apply criticism. Feedback does not facilitate learning automatically. How students recognize, comprehend, and use it during revision determines how valuable feedback is.

This concern is one indication of a broader shift in applied linguistics studies. Across the field, there is a move away from a product-based orientation and toward a process-based perspective on learning. From a cognitive perspective, learning is demonstrated not only in a product of writing but also in the mental activity that occurs as a learner engages with writing.

As students engage with feedback, they also engage in mental activity. Thus, in this light, feedback on writing should be understood both as a mental process and a teaching instrument. Indeed, Allwright (1975) highlighted that a learner's interpretation of feedback plays more important role in the success of a correction than teachers' intention. Feedback is unlikely to aid in learning if students are disinterested, confused, or frustrated. According to this perspective, learner involvement is crucial for the effectiveness of feedback.

How learners perceive the significance of errors also determines how they interact with feedback. According to Ellis (2009), there may be disagreements between students and teachers regarding the gravity of some mistakes. Since no theory provides an unambiguous answer to which errors are the most significant, students may pay a great deal of attention to some comments and disregard others (Van Beuningen, 2011).

Given these findings, it is surprising that most studies on written feedback have focused on final texts rather than thought processes. Hyland (1998) points out that, often, learners may only take up some of the feedback given to them. Ferris (1995) argues that feedback will only be effective when students read them carefully and think about them. However, the findings here are mixed. Some studies, for example, found that students ignore teacher feedback once the grades are known (Cohen, 1987). According to other research, students take feedback seriously when they think it will be useful to improve the quality of their writing (Cohen & Cavalcanti, 1990).

The use of retrospective data to understand how students process feedback is one of its primary flaws in previous studies. According to Bouwer and Dirkx (2023), interviews and stimulated recall rely on memory and recollection, which may not be accurate and might not reveal real-time processing. Additionally, Winstone et al. (2017) demonstrated that learners' emotional and motivational hurdles affect their utilization of feedback. Due to these genuine concerns, researchers have adopted eye-tracking techniques that record students' visual attention while they receive feedback.

Theoretical Framework: Noticing and Cognitive Engagement

The noticing hypothesis is the basis of the majority of eye-tracking studies on written corrective feedback. Based on this theory, learners have to consciously notice and be aware of the language features in order to learn from them (Schmidt, 1990). From this perspective, feedback may only facilitate learning when students pay attention to the corrective information provided by their teachers and apply it to their own writing.

Noticing is not always instinctive. Students may look at feedback but may not always understand it. They might also read feedback but may not utilize it or apply it correctly. Therefore, cognitive engagement with feedback requires varying levels of focus, comprehension, and effort.

As eye movement and attention are closely associated, eye tracking helps researchers in studying this process. It is typically considered active thinking when students look at feedback for extended periods of time, revisit it frequently, or shift their gaze between the feedback and their own content. It requires more than just reading comments to engage cognitively with feedback. Cognitive engagement involves more in-depth processes like comparing forms, idea testing, and decision-making. Eye-tracking machine helps observe these processes during revision as it measures fixation time and gaze shifts.

Using Eye Tracking to Investigate Feedback Engagement

Researchers can use eye tracking to document where students look and how long they stare at a screen while making revisions. The majority of research investigated feedback engagement include students revising their texts on a computer while a high-frequency eye tracker records their eye movement. This produces a detailed data of visual attention or eye behavior over time. The screen has to be divided into areas of interest by researchers. They are of interests typically feature learner text, error locations, and feedback remarks. For every location, eye-tracking measures are calculated. Common measures include fixation count, which indicates how frequently students return to feedback, total fixation time, which indicates overall attention, and fixation duration, which indicates how long students focus on a single location. Gaze shifts between text and feedback demonstrate how students relate comments to their writing. These measures usually not used alone; rather, they are combined. To enhance interpretation, many studies integrate eye-tracking data with screen recordings, verbal data, and revision outcomes (Bouwer & Dirkx, 2023). This combination helps researchers to understand what visual attention implies from a learning perspective.

Students' Interaction with Automated and Teacher-Provided Written Feedback

Several eye-tracking studies have investigated how students respond to written corrective feedback. These studies demonstrate how various forms of feedback result in various thought and attention patterns. In Shintani and Ellis's (2013) study, selected students were made to revise their writing while their eye movements were monitored. The study compared metalinguistic feedback, which described the kind of error, with direct feedback, which provided the correct form. According to eye-tracking data, metalinguistic feedback resulted in longer fixation times and more eye movements between feedback and learner text. Students frequently glanced back and forth between the explanation and the error which indicated that they were attempting to understand and implement the rule. A different pattern was observed for direct

feedback. Learners spent less time looking at the feedback and made fewer eye movements between feedback and text. They corrected errors quickly and accurately, but with less evidence of deeper thinking. These results suggest that while direct feedback facilitates faster revision, metalinguistic feedback pushes learners toward deeper cognitive engagement.

Other studies have examined learners' engagement with feedback across various writing categories. El Ebyary and Windeatt (2019) examined how EAP learners engage with computer-mediated feedback on language use, grammar, mechanics, style, and organization. Eye-tracking measures showed that learners consistently focused more on grammar and organization feedback than on other categories. Grammar feedback was usually read first and received the longest fixation times. Organization feedback also received long fixations, often because learners found it difficult to understand. Although fixation time decreased in later drafts, learners' attention patterns stayed the same. Stimulated recall interviews showed that learners' past instruction strongly influenced how they processed feedback.

These studies demonstrate that learners do not treat all feedback equally. Their engagement depends on feedback type, perceived difficulty, and beliefs about what matters in writing. Eye tracking has also been used to investigate learners' involvement with automated written feedback systems. These studies show that feedback explicitness strongly shapes attention and processing. Liu and Yu (2022) examined how learners engaged with direct and indirect automated feedback. Fixation duration, fixation count, and gaze transitions between learner text and feedback were among the eye-tracking measures. It was found that indirect feedback resulted in longer fixations and more frequent transitions. Learners frequently paused on feedback and switched back and forth between it and the text, indicating that they were making an attempt to solve the problem. Direct feedback resulted in shorter fixation times but facilitated more immediate and accurate corrections. Since the correct form was already provided in direct feedback, learners didn't need to think as much. In contrast to direct input, which enabled learners to make judgments more quickly, indirect feedback required guesswork and idea testing, according to stimulated recall interviews. These results demonstrate how the design of feedback impacts learners' attention and engagement with the feedback, which lends support to the noticing hypothesis. These findings also point to a tradeoff student's face: should they think more deeply or revise more quickly?

Most recently, studies have investigated the way students interact with AI-generated feedback in L2 writing. Ma et al. (2026) examined learners' interaction with AI-generated feedback by using behavioral data and revision outcomes. The study focused on the qualitative data collected from various textual sources and in-depth interviews to explore six Chinese EFL students' cognitive, behavioral, and affective engagement with AI feedback from ChatGPT. The findings revealed that learners were selective in dealing with AI-generated feedback. They were more willing to accept suggestions

without critically analyzing them and would attend to obvious surface-level issues such as grammar and vocabulary. Although this led to quick revisions, it did not support deeper learning and long-term improvement always. In behavioral terms, learners showed greater responsiveness to local than global feedback. Only one student expressed skepticism about AI feedback, but most participants showed negative attitudes toward AI-generated comments. They applied revision strategies like prioritizing what to revise and consulting outside sources. The results demonstrated that learners' involvement depended on their degree of trust in the AI system and their ability to critically evaluate feedback. Those who challenged the feedback and compared it with their existing knowledge engaged more deeply and revised more effectively. Thus, this study further indicates that AI-generated feedback can assist revisions, but this assistance is conditional on the active processing and evaluation of the feedback by learners rather than their acceptance of it.

Interaction with Context-Rich and Multimodal Feedback

Multimodal feedback, which integrates text, voice, and video, has also been studied in recent eye-tracking studies. According to these studies, learner engagement with feedback is not always limited to marked errors. Laura and Yang (2021) is one such study that examined learners' interaction with video-based feedback in L2 Spanish writing using eye tracking. While their eye movements were being monitored, learners watched educational and tailored feedback movies. Successful revision was associated with longer fixation periods, particularly for vocabulary and verb errors. Significantly, students did not just concentrate on the highlighted errors. Eye-tracking data revealed that students also looked at nearby unmarked text for extended periods of time. This suggests that feedback processing is not confined to the marked area alone but rather occurs in the larger context of meaning of the text. Thus, noticing involves understanding how feedback contributes to the overall message, rather than being limited to individual linguistic forms.

In this context, recent research has contributed to expanding the boundaries of this line of inquiry by investigating students' engagement with feedback generated by AI. Cao, Chen, and Wei (2026) used eye-tracking metrics like fixation duration, stay time, and gaze transitions to compare students' visual attention to teacher-provided multidimensional feedback versus GenAI-generated feedback. This study focused on three types of feedback: vocabulary, grammar, and general organization, which together constitute multidimensional feedback. The results indicated that students' attention to feedback type depended on the source of feedback. With GenAI feedback, which focused more on surface issues like grammar and word choice, students quickly moved back and forth between their text and the comments. This suggests they processed each piece of feedback faster, but not very deeply. In contrast, teacher feedback led students to focus more on bigger aspects of writing, such as organization and coherence. This means that while GenAI feedback can help students make corrections, it may encourage them to focus more on small details rather than fully understanding the overall meaning and structure of their writing. The study also found

that when using GenAI feedback, students moved between the feedback and their text less often, which suggested that they made fewer comparisons between the two. The above results point to the need to guide learners in using AI-generated feedback more critically to help them improve their writing accuracy and promote deeper cognitive engagement with writing.

Learners' Response to Peer Feedback

Additionally, eye tracking has been used to investigate how students perceive peer feedback. These studies emphasize the importance of social variables and the quality of feedback. Bolzer et al. (2015) discovered that longer fixations and more gaze shifts between feedback and learner text were associated with precise and detailed peer feedback. Learners spent time understanding comments before revising. In contrast, vague feedback received shorter fixations and was often skimmed. Berndt et al. (2018) showed that learners' beliefs about the feedback provider also shaped engagement. Feedback believed to come from a competent peer attracted longer fixations and closer attention. Eye-tracking data showed stronger integration between feedback and learner text when learners trusted the source. In this sense, social judgment influences cognitive engagement with feedback along with linguistic features.

Visual Engagement, Learning Outcomes, and Transfer

Some recent studies have linked eye-tracking data to actual learning outcomes. Karim (2025) compared direct and indirect focused written corrective feedback during revision and in later writing tasks. Eye-tracking measures included fixation duration and dwell time on feedback areas. Learners who spent more time visually attending to feedback showed higher accuracy during revision. These gains were also seen in delayed writing tasks. Explicit feedback attracted focused attention and supported both short-term correction and longer-term learning. This study shows that visual engagement with feedback can predict learning transfer.

Implications and Research Gaps

Taken together, these studies have shown that learners are selective in how they engage with feedback and that this engagement is determined by a complex interplay of cognitive, instructional, and social factors. With the help of eye tracking, researchers have been able to observe how students respond to feedback in real time. However, eye tracking alone cannot adequately describe the mental processes that students go through when processing input. The feedback processing framework developed by Ronald P. Leow (Leow & Driver, 2021) highlights that attention is just one aspect of feedback processing. Leow and Bowles (2023) elaborated that comprehending feedback requires awareness, hypothesis testing, and strategic thinking, all of which are not able to be captured by eye tracking alone. They suggest that think-aloud protocols are necessary and can play an important role because they allow students to express their thoughts while responding to feedback.

Studies that combined verbal protocols with eye tracking were able to interpret gaze data more effectively and accurately. Sometimes longer fixations were more indicative of confusion rather than learning. Such fixations could be interpreted wrongly as serious engagement in the absence of verbal data. More research should integrate eye tracking with think-aloud procedures or stimulated recall because eye tracking alone might not accurately reflect cognitive processes during feedback intake. This design not only explains where students look, but also clarifies why they look and what they comprehend.

Despite all these advancements, some gaps still exist. Research is still dominated by short tasks with small samples. Longer-term research is needed to map relationships between writing development and engagement patterns. More studies need to be conducted on higher-order input, such as content and structure. On the whole, eye-tracking research indicates that whether feedback works depends on how it is provided and how students focus on and process it as they apply it. This integrated approach will allow future research to shed light on how feedback facilitates learning, rather than simply determining whether it does so.

One of the pressing concerns raised in recent studies is the new nature of engagement that learners show toward the feedback given in an AI-enhanced learning environment. While traditional WCF studies emphasized depth of processing as a key factor for learning, newer studies suggest that learners may adopt faster but more surface-level processing strategies when interacting with automated or AI-generated feedback. Such results re-raise the central question regarding the nature of "effective" engagement: Does quicker correction necessarily indicate learning, or does it suggest the use of support at one's disposal? Eye-tracking evidence suggests that shorter fixation durations in AI contexts may indicate reduced cognitive effort, which could limit long-term learning gains. This implies that further studies should reexamine how learner engagement should be conceptualized and operationalized within technology-rich environments.

The second and most important implication relates to the role of learner training. Studies such as Cao et al. (2026) and Ma et al. (2026) show that learners do not automatically engage deeply with feedback, especially when it is easily accessible or automatically generated. Without guidance, learners may prioritize efficiency over understanding. This, in turn, suggests that pedagogical interventions are necessary to help learners slow down, reflect on, and critically analyze feedback. For example, instructors can design tasks that require learners to explain corrections, compare alternatives, or justify revisions. Such activities may lead to longer fixation durations and more transitions between the feedback and the text, which, according to previous research, are indicators of deeper processing. Eye-tracking studies, therefore, go beyond describing how learners respond to feedback and may provide implications for better feedback practices.

Theoretically, these findings call into question the adequacy of the noticing hypothesis as a stand-alone construct for describing the processing of feedback. Noticing remains important, but recent studies show that mere attention is insufficient. Learners should be involved in the evaluation of feedback, making decisions about which feedback to accept and which to reject, and in integrating accepted feedback into their developing language system. This aligns with Leow and Bowles (2023) argument that awareness and cognitive effort go beyond visual attention. Therefore, future WCF models should include attention, cognition, and context, with an emphasis on increasing digitalized learning environments.

Conclusion

This reflection paper has examined the processing of written corrective feedback from the perspective of eye-tracking studies, which have added a new dimension to the effectiveness of feedback by showing that effectiveness cannot be determined simply by what feedback is given but rather by how learners attend to, interpret, and use the feedback in revising their texts. Eye-tracking studies fill a gap here, providing evidence of the underlying processes of visual attention to feedback, which cannot be captured in the final product alone. The paper also points out recent developments in the field, particularly the growing focus on the expanding role of AI-generated feedback. New studies from 2026 show that while such feedback can increase efficiency, it may also lead to more surface-level processing unless learners are trained to engage critically. This implies that instead of just looking at direct vs. indirect feedback, future studies need to examine other factors like feedback source, learner agency, and digital context. Overall, the results highlight the need for integrated research designs that integrate verbal and performance data with eye tracking. These methods can provide a more holistic understanding of how feedback facilitates learning. Future studies should focus on investigating learners' progress over a longer period, include large sample size, and examine more complex aspects of writing. By adopting these guidelines researchers can better understand and explain not only whether feedback is effective, but also how and why it contributes to second language development.

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