

Exploring learner attention and processing in second language writing: The role of eye-tracking and written corrective feedback

Barry Lee Reynolds

Faculty of Education, University of Macau, Macau SAR, China

Centre for Cognitive and Brain Sciences, University of Macau, Macau SAR, China

Correspondence

Email: BarryReynolds@um.edu.mo

Abstract

This paper highlights the importance of the timing of feedback and distinguishing between instruction and feedback in the context of written corrective feedback (WCF) for second language (L2) learners. It proposes the integration of eye-tracking and qualitative data collection methods to assess learner attention and WCF processing. The reviewed eye-tracking studies demonstrate the potential of this approach, revealing correlations between learners' noticing and subsequent writing improvements. However, the limited studies utilizing eye-tracking in this area calls for further research to explore the benefits of metalinguistic explanations provided before or after writing production. Additionally, the paper emphasizes the need to address the dominance of quantitative approaches in WCF literature and encourages the combination of eye-tracking with qualitative data sources to broaden our understanding of revision as negotiation. It suggests investigating the impact of different feedback modes and languages, especially in younger L2 writers and diverse writing systems. Moreover, the paper advocates for ecologically valid experiments that involve eye-tracking during revision with feedback present, considering the various types of feedback and their influence on learners' noticing and subsequent writing improvements. Addressing these concerns will contribute to a comprehensive understanding of WCF, noticing and processing feedback, L2 writing production, and effective pedagogical practices.

ARTICLE HISTORY

Received: 05 April 2023

Revised: 22 September 2023

Accepted: 27 October 2023

KEYWORDS

eye-tracking, written corrective feedback, L2 writing, noticing, processing

Introduction

For second language (L2) learners to benefit from written corrective feedback provided on their L2 written production, it is crucial for them to notice the feedback given on their errors. This noticing serves as an initial step in language acquisition (Schmidt, 1995) since attention is required for learners to recognize and internalize

the feedback. Through this process, language input can transform into intake, potentially leading to improvements in learners' language production (Schmidt, 1990).

However, a significant amount of literature on the effectiveness of written corrective feedback has been produced under the assumption that the participants recruited in these studies have indeed noticed, processed, and utilized the feedback received, often without specific instruction on the types of errors corrected (Kepner, 1991; Truscott & Hsu, 2008; Van Beuningen et al., 2012; Zhang, 2021). Moreover, the absence of a reliable means to measure this noticing has made it challenging for researchers to conclusively claim that improvements or lack thereof in L2 writing result from learners' attention and processing of the written corrective feedback provided by teachers, peers, or others. While options such as think-aloud and stimulated recall data collection techniques exist, they may increase cognitive load and potentially divert learners' attention away from the written corrective feedback, introducing an unwanted intervening variable (Gass & Mackey, 2017). This commentary echoes the recent call to use eye tracking "to deepen our understanding of the contribution of mode to the feedback process" as it can "deepen our understanding of the... feedback process" (Chang et al., 2017, p. 11).

In this paper, I propose that eye-tracking data collection methods may offer a better alternative for assessing learner attention and processing of written corrective feedback in their L2 writing. Eye-tracking can allow researchers to obtain real-time observations of learner attention and processing of written corrective feedback in the form of eye fixations (i.e., frequency counts and durations) or saccades (i.e., quick, rapid eye movements from one point to another). Correlations between eye-tracking data and subsequent revisions of learner writing can also provide further empirical support for the noticing hypothesis (Schmidt, 1993). Similarly, for researchers who provide instruction on either targeted linguistic knowledge or how to interpret and use written corrective feedback, the use of an eye-tracker can clearly indicate what aspects of the language input the learners pay attention to (Smith, 2012). While it is true that eye-tracking and related cognitive science data collection techniques often reduce the ecological validity of experiments due to their controlled laboratory conditions, they still allow researchers to establish more direct connections between L2 writing improvement, written corrective feedback, and the processing of written corrective feedback.

A survey of the literature revealed very few studies that have used eye-tracking in written corrective feedback research. Specifically, a title search of the SSCI, ESCI, and Scopus databases using feedback and eye-tracking search terms revealed only four empirical papers that used eye-tracking in written corrective feedback studies (see Table 1).

Table 1
Reviewed Studies Utilizing Eye-tracking Data Collection

Study	L1	L2	N	Location	Feedback type	Error Type(s)	Writing	Education level	Theory	Methodology	Eye-tracking Stimuli
Smith (2012)	Mixed	English	18	USA	Direct unfocused written recasts	Morphological errors; semantic errors; syntactic errors	Text-based synchronous computer-mediated communication	University	Noticing Hypothesis	Quantitative	Video
Shintani and Ellis (2013)	Mixed	English	6 ^a	USA	Direct focused feedback and direct focused metalinguistic explanation	Indefinite article	Narrative	Pre-sessional	Skill-learning Theory	Mixed method	Word processing electronic document
Valentin-Rivera and Yang (2021)	English	Spanish	3	USA	Indirect focused written corrective feedback	Lexical, spelling, verb-related, missing word, agreement	Narrative	University	Noticing Hypothesis	Quantitative	Video
Liu and Yu (2022)	Chinese	English	24	China	Automated feedback (indirect and direct unfocused written corrective feedback)	Word-level and sentence-level errors	Descriptive	University	Conceptual Framework (Key Processing Stages of Written Corrective Feedback (Bitchener & Storch, 2016; Bitchener, 2017) + Five Stages of Learner Engagement with Feedback (Gass, 2018)	Mixed methods	Write & Improve with Cambridge free online English learning and test preparation platform

Note. ^a 49 participants were also recruited for the different control and experimental groups; however, eye tracking data was not collected from these participants.

Below, I provide a summary of these studies before discussing the future of written corrective feedback research and the use of eye-tracking data collection. Although the researchers may have collected multiple types of data and employed various data collection methods, I focus solely on the use of eye tracking in this discussion.

Previous Written Corrective Feedback Studies Utilizing Eye-tracking

Smith (2012) utilized eye-tracking to observe the gaze patterns of 18 English L2 learners at a university. These learners received explicit recasts as corrective feedback during synchronous computer-mediated communication with a first language (L1) interlocutor. The researcher aimed to determine whether noticing events, measured through eye-tracking data and stimulated recall, correlated with accuracy in language production on immediate and delayed posttests. The results indicated that participants' noticing of the feedback, as evident in both the eye-tracking and stimulated recall data, corresponded to their performance on the posttests. However, the methods description did not clearly specify whether eye-tracking data was collected solely during the stimulated recall or in combination with online data from the synchronous communication. Nevertheless, the study emphasized the potential of eye-tracking as a tool to explore the relationship between processing corrective feedback and subsequent language production. The collected eye-tracking data was relatively broad, lacking clearly defined regions of interest. This was likely due to the study's flexible methodology, which aimed to encourage participants to produce language that was ecologically valid, albeit within the confines of a somewhat artificial language task. The produced heatmaps only offered a rough estimate of participants' attention to specific parts of the written chat transcripts. Nonetheless, this study clearly highlights the future potential for researchers to utilize eye-tracking to investigate how increased visual attention to written corrective feedback can improve subsequent language production accuracy. Another important aspect of the study was the inclusion of various steps to ensure that learners understood the feedback provided and how they could use it to correct their written language production.

Shintani and Ellis (2013) compared the effects of direct corrective feedback and metalinguistic explanation on the use of indefinite English articles in a study involving 49 English as a second language students. Additionally, eye-movement measurements and stimulated recall interviews were conducted with an additional six students. The findings indicated that direct corrective feedback had no impact on subsequent production of indefinite English articles. In contrast, metalinguistic explanation appeared to lead to improvements in immediate writing but not in a delayed piece completed two weeks later. These results suggested that metalinguistic feedback facilitated implicit knowledge and rule development, which was not possible with direct corrective feedback. Eye movement data was collected to examine how direct corrective feedback and metalinguistic feedback influenced the use of indefinite English articles. No clear differences were found between the fixations or their

duration on errors and corrections in the revised texts for the two groups. While all learners who received direct corrective feedback fixated on their errors, the fixations were relatively brief, possibly indicating insufficient time for them to process the feedback. This suggests that they noticed the errors but did not achieve a conscious level of understanding regarding the error or the violated grammar rule. However, due to the small sample size, these results were inconclusive, making it challenging to draw generalizations from the data.

Valentin-Rivera and Yang (2021) employed eye-tracking to examine the attention of three L2 Spanish learners at a university. They focused on the learners' attention to instruction delivered through a YouTube video, as well as individualized feedback provided through a silent video. The aim was to determine how this attention correlated with improvements in writing during subsequent essay revisions. The researchers explored the relationship between noticing written corrective feedback (measured using an eye-tracker) and accurate revisions of learners' writing. Overall, learners who paid more attention to the feedback made more revisions, particularly regarding verb and vocabulary-related errors. In other words, increased noticing, particularly through an audiovisual tutorial that taught learners how to interpret and utilize subsequent written corrective feedback, positively contributed to the learners' subsequent revisions of their writing.

Liu and Yu (2022) employed eye-tracking, stimulated recalls, and reflective journals to gain insight into how 24 second language writers at a university in China engaged with automated indirect and direct feedback provided by the automated writing evaluation platform, *Write & Improve with Cambridge*. The data revealed that participants spent more time processing indirect feedback compared to direct feedback. However, this increased processing did not result in significant improvements in the participants' second language writing after revisions. The authors suggested that more explicit feedback and/or scaffolding were necessary for second language writers to benefit from the types of feedback provided by the automated writing evaluation system.

While reviewing these studies, I identified several similarities and differences among them. Firstly, all four studies aimed to establish a connection between the processing of written corrective feedback and subsequent improvements in writing. Secondly, they all incorporated eye-tracking data alongside other types of data collection. Lastly, they emphasized the significance of learners' understanding and utilization of feedback to enhance their language production. However, there were differences in the participant samples, which were generally small across all studies. Additionally, they examined different types of feedback, such as explicit recasts during computer-mediated communication (Smith, 2012), instructional videos (Valentin-Rivera & Yang, 2021), direct corrective feedback and metalinguistic explanation (Shintani & Ellis, 2013), and automated indirect and direct feedback provided by a writing evaluation platform (Liu & Yu, 2022). The studies also varied in the timing of

assessments and the types of language tasks used. Moreover, they employed different approaches to analyze the eye-tracking data, with some focusing on gaze patterns and heatmaps (e.g., Smith, 2012), while others examined fixations specifically related to errors and corrections (e.g., Shintani & Ellis, 2013). Nevertheless, these studies collectively demonstrate the usefulness of eye-tracking in investigating the noticeability of written corrective feedback, paving the way for future research to delve into the intricate details of this relationship.

Areas for Future Research

Metalinguistic explanation is usually considered as a type of written corrective feedback when provided to research participants after they have completed a piece of writing. Interestingly, in the reviewed eye-tracking studies (e.g., Smith, 2012; Valentin-Rivera & Yang, 2021), the metalinguistic explanation was provided to the participants before they had engaged in written language production. This has been termed as “teacher instruction” in some previous written corrective feedback literature (e.g., Reynolds & Kao, 2021). An interesting future area of exploration with the use of eye-tracking would be to examine whether learners benefit more from receiving such instruction (i.e., metalinguistic explanations) either before or after producing their second language writing. It is likely that such feedback has mostly occurred after learners have produced their second language writing as the researchers will need to anticipate what grammatical or lexical errors are likely to be produced by the learners. Researchers can evaluate the attention given to the language instruction or metalinguistic explanation to gauge whether receiving such instruction before or after second language writing production can increase attention and whether this increased attention results in improvements in the language targets produced in subsequent drafts.

Many previous studies on written corrective feedback have often merged instruction with feedback, creating a potential conflation. While some researchers have emphasized the significance of learners' attention, processing, and integration of written corrective feedback, they have also recognized the necessity of providing learners with instructional support to interpret the feedback or receive metalinguistic instruction. However, it should be noted that teaching learners about specific grammatical constructions and teaching them how to effectively utilize written corrective feedback, including addressing specific grammatical or lexical errors, may be perceived as distinct cognitive processes by learners.

Future research should focus on understanding learners' capacity to benefit from instruction. This entails considering the distinct cognitive processes at play in grammar and vocabulary acquisition, as well as the effectiveness of written corrective feedback. Instructional interventions should explicitly address both aspects, while also taking into account learners' perceptions and needs.

Some argue that a significant portion of the literature on written corrective feedback is dominated by quantitative approaches. Encouraging the use of eye-tracking as a data collection technique entails the risk of further emphasizing quantitative data, while overlooking the valuable insights that can be gained through the collection of qualitative data. Therefore, I encourage researchers who employ eye-tracking in their future studies to combine it with data obtained from stimulated recall, reflection journals, interviews, and other qualitative sources. This approach may facilitate a shift in the written corrective feedback literature, moving from a narrow view of revision as mere correction to a broader perspective of revision as negotiation. Furthermore, I urge researchers to thoroughly investigate the process of revision and the role played by written corrective feedback in the changes made across multiple revisions (i.e., drafts) of a written piece. This will enhance the ecological validity of the written corrective feedback literature that utilizes eye tracking.

While not specifically centered on L2 writing feedback, Bouwer and Dirkx (2023) offer a valuable framework for integrating both online and offline approaches to elucidate students' interaction with feedback provided by instructors subsequent to the completion of writing assignments. Their approach involved administering personalized feedback to a limited cohort of students in study 1 (n = 16), followed by presenting exemplar feedback from previous academic years' student work for analysis by a broader sample in study 2 (n = 41). In study 1, three distinct feedback processing strategies emerged: superficial processing, local processing, and deep processing. Study 2 delved further into the realm of deep processing by administering various forms of feedback, revealing that the emphasis of the feedback influenced students' revision tendencies. This methodology offers a promising avenue for further exploration.

Given the increasing affordability of wearable eye-tracking devices, such as eye-tracking glasses, it is reasonable to suggest that researchers now explore alternative modes of feedback provided to writing in the classroom. Specifically, attention and processing of both oral and written corrective feedback can lead to improvements in L2 writing. In some writing classrooms, teachers often supplement written corrective feedback provided on drafts with oral corrective feedback during "conferencing" sessions. Eye-tracking glasses can gather valuable data on how learners allocate attention to the teacher's oral feedback and the feedback given on the student's draft. Additionally, eye-tracking devices can measure cognitive processing through pupil size, offering insights into questions such as the impact of feedback mode (written vs. oral) or feedback language (L1 vs. L2) on students' noticing. Similarly, eye-tracking measurements can gauge understanding of instruction regarding the interpretation of written corrective feedback or metalinguistic explanations of specific language production rules. This unexplored territory holds great potential for further investigation.

One critical concern that appears to have been overlooked by researchers utilizing eye tracking data in studies on written corrective feedback is the significance of the accuracy and precision of such data. It is essential for future researchers intending to incorporate eye tracking into their experimental designs to ensure adherence to guidelines that guarantee both accuracy and reliability in data collection (Dalrymple et al., 2018). Interested readers are encouraged to consult the works of Conklin et al. (2018) and Godfroid (2019) for further insights on this topic. New eye-tracking methods of capturing writers' typing while visually attending to emerging text have already been developed (Wengelin et al., 2023) and are sure to provide much insight into how learners revise texts while attending to teaching feedback. In the age of ChatGPT and similar AI tools, researchers must also consider not whether but how learners engage with such tools in connection to teacher feedback when they seek for writing assistance (Langner, et al., 2023). Addressing these concerns will ensure the robustness and validity of future research findings, thereby contributing to a comprehensive understanding of noticing, processing, written corrective feedback, and L2 writing production.

All the research participants in the reviewed studies were either studying in a university or preparing to do so. This highlights the need to expand research and investigate how attention, processing, and written corrective feedback interact for the development of younger second language writers. While it was encouraging to see at least one study focusing on a language other than English, there is still ample room to explore writing and feedback within different writing systems, such as Chinese, Korean, and Arabic.


Moreover, it would be beneficial to develop techniques for gathering eye tracking data while learners revise their drafts and refer to the received feedback. Many existing studies only provide learners with a brief period to review feedback before producing another piece of writing, which may not accurately reflect real-life writing scenarios. When people receive feedback on their writing, they often have the feedback in front of them while revising. Therefore, there is a need for studies that create more ecologically valid experimental situations. Additionally, there is ample scope for researchers to explore different types of feedback and how these feedback types influence learners' noticing of errors and subsequent improvements in their writing.

Conclusion

With the noticeable decrease in the cost of eye-tracking apparatus in recent years, the previous hindrance for feedback researchers has shifted. It is no longer the prohibitive expense, but rather the time required for configuring the equipment in a manner conducive to generating ecologically valid individualized feedback within authentic settings while still facilitating effective data collection. This paper aims to serve as a source of inspiration for those undaunted by such a demanding endeavor, encouraging them to be at the forefront of this field. Despite its time-intensive nature, the investment in time is bound to yield invaluable linguistic insights. In conclusion, this

paper has emphasized the significance of investigating the timing of feedback and the distinction between instruction and feedback with the use of eye tracking. Future research should integrate eye-tracking and qualitative data collection methods, explore various feedback modes, ensure accuracy in eye tracking data, and examine diverse learner populations and writing systems to enhance our understanding of written corrective feedback and inform pedagogical practices.

ORCID

 <https://orcid.org/0000-0002-3984-2059>

Acknowledgements

The author appreciates the feedback given by Shizhou Yang on an earlier draft of this manuscript.

Funding

Not applicable.

Ethics Declarations

Competing Interests

No, there are no conflicting interests.

Rights and Permissions

Open Access

This article is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/), which grants permission to use, share, adapt, distribute and reproduce in any medium or format provided that proper credit is given to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if any changes were made.

References

- Bitchener, J. (2017). Why some learners fail to benefit from written corrective feedback. In H. Nassaji, & E. Kartchava (Eds.), *Corrective feedback in second language teaching and learning: Research, theory, applications, implications* (pp. 129-140). Taylor & Francis.
- Bitchener, J., & Storch, N. (2016). *Written corrective feedback for L2 development*. Multilingual Matters.
- Bouwer, R., & Dirkx, K. (2023). The eye-mind of processing written feedback: Unraveling how students read and use feedback for revision. *Learning and Instruction*, 85, 1-10. <https://doi.org/10.1016/j.learninstruc.2023.101745>
- Chang, C., Kelly, J.C., Satar, H.M., Strobl, C. (2017). Electronic feedback on second language writing: A retrospective and prospective essay on multimodality. *Writing & Pedagogy*, 9(3), 405-428. <https://doi.org/10.1558/wap.32515>
- Conklin, K., Pellicer-Sánchez, A., & Carrol, G. (2018). *Eye-tracking: A guide for applied linguistics research*. Cambridge University Press.
- Dalrymple, K. A., Manner, M. D., Harmelink, K. A., Teska, E. P., & Elison, J. T. (2018). An examination of recording accuracy and precision from eye tracking data from toddlerhood to adulthood. *Frontiers in Psychology*, 9, 1-12. <https://doi.org/10.3389/fpsyg.2018.00803>
- Gass, SM. (2018). *Input, interaction, and the second language learner* (2nd ed.). Routledge.
- Gass, S.M., & Mackey, A. (2017). *Stimulated recall methodology in second language research* (2nd ed.). Routledge.

- Godfroid, A. (2019). *Eye tracking in second language acquisition and bilingualism: A research synthesis and methodological guide*. Routledge.
- Kepner, C.G. (1991). An experiment in the relationship of types of written feedback to the development of second language writing skills. *Modern Language Journal*, 75, 305-313. <https://doi.org/10.1111/j.1540-4781.1991.tb05359.x>
- Langner, M., Toreini, P., & Maedche, A. (2023). Leveraging eye tracking technology for a situation-aware writing assistant. In E. Kasneci, F. Shic, & M. Khamis (Eds.), *ETRA '23: Proceedings of the 2023 Symposium on Eye Tracking Research and Applications* (Article 46, pp. 1-2). ACM. <https://doi.org/10.1145/3588015.3590121>
- Reynolds, B.L., & Kao, C.-W. (2021). The effects of digital game-based instruction, teacher instruction, and direct focused written corrective feedback on the grammatical accuracy of English articles. *Computer Assisted Language Learning*, 34(4), 462-482. <http://doi.org/10.1080/09588221.2019.1617747>
- Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics*, 11, 129-158. <https://doi.org/10.1093/applin/11.2.129>
- Schmidt, R. (1993). Awareness and second language acquisition. *Annual Review of Applied Linguistics*, 13, 206-226. <https://doi.org/10.1017/S0267190500002476>
- Schmidt, R. (1995). Consciousness and foreign language learning: A tutorial on the role of attention and awareness in learning. In R. Schmidt (Ed.) *Attention and awareness in foreign language learning* (pp. 1-63). University of Hawai'i.
- Smith, B. (2012). Eye tracking as a measure of noticing: A study of explicit recasts in SCMC. *Language Learning & Technology*, 16(3), 53-81. <http://llt.msu.edu/issues/october2012/smith.pdf>
- Truscott, J. & Hsu, Y.P. (2008). Error correction, revision, and learning. *Journal of Second Language Writing*, 17, 292-305. <https://doi.org/10.1016/j.jslw.2008.05.003>
- Valentin-Rivera, L.E., & Yang, L. (2021). The effects of digitally mediated multimodal indirect feedback on narrations in L2 Spanish writing: Eye tracking as a measure of noticing. *Languages*, 6, 1-19. <https://doi.org/10.3390/languages6040159>
- Van Beuningen, C. G., De Jong, N. H., & Kuiken, F. (2012). Evidence on the effectiveness of comprehensive error correction in second language writing. *Language Learning*, 62, 1-41. <https://doi.org/10.1111/j.1467-9922.2011.00674.x>
- Wengelin, Å., Johansson, R., Frid, J., & Johansson, V. (2023). Capturing writers' typing while visually attending the emerging text: A methodological approach. *Reading and Writing*. <https://doi.org/10.1007/s11145-022-10397-w>
- Zhang, T. (2021). The effect of highly focused versus mid-focused written corrective feedback on EFL learners' explicit and implicit knowledge development. *System*, 99, 1-16. <https://doi.org/10.1016/j.system.2021.102493>