Philology Matters / ISSN: 1994 – 4233 / E-ISSN: 2181–1237
Uzbekistan State World Languages University
2026 Vol. 1 No. M 4
LINGUISTICS
DOI: 10.36078/987656200

Javohirbek Tolibjonov

Uzbekistan State University of World Languages
Tashkent, Uzbekistan
E-mail: tolibjonovjavohir1@gmail.com

Scientific Supervisor: Nodira Kushiyeva – D.P.Sc., associate professor

THE USE OF INNOVATIVE TECHNOLOGIES IN ENGLISH LANGUAGE TEACHING (COMPUTER-BASED LEARNING)

Abstract. This article examines the effectiveness of computer-based technologies in teaching English as a foreign language (EFL). The study is based on a narrative review of ten academic publications published between 2018 and 2025. It explores the impact of computer-aided learning on students' motivation, learner autonomy and classroom organization, while identifying the main challenges associated with integrating digital technologies into language education. Particular attention is given to interactive multimedia resources, digital learning tools, computer-assisted assessment systems and opportunities for immediate feedback. The findings indicate that computer-based learning can enhance students' motivation and interest, support vocabulary retention and promote more interactive classroom activities. It also provides learners with flexible access to educational materials and opportunities for independent practice. However, the effectiveness of technology integration depends on several factors, including adequate technical infrastructure, appropriate software, teachers' digital competencies and learners' ability to regulate their own learning. The review also highlights the limited availability of empirical evidence demonstrating improvements in English language achievement specifically. Therefore, further controlled studies in EFL classrooms are needed to establish the educational impact of computer-based learning. The article emphasizes the importance of combining digital technologies with traditional teaching methods to create a more flexible, interactive and learner-centered educational environment.

Keywords: computer-based learning, computer-assisted language learning, English as a foreign language, innovative technologies, interactive multimedia, digital education.

Javohirbek Tolibjonov

O‘zbekiston davlat jahon tillari universiteti
Toshkent, O‘zbekiston

Ilmiy rahbar: Nodira Kushiyeva – p.f.d., dotsent

INGLIZ TILINI O‘QITISHDA INNOVATSION TEXNOLOGIYALARDAN FOYDALANISH (KOMPYUTERGA ASOSLANGAN TA’LIM)

Annotatsiya. Mazkur maqolada ingliz tilini xorijiy til sifatida o‘qitishda kompyuter texnologiyalaridan foydalanish samaradorligi tahlil qilinadi. Tadqiqot 2018–2025-yillarda nashr

etilgan o‘nta ilmiy maqolaning narrativ sharhiga asoslangan bo‘lib, unda kompyuter yordamida o‘qitishning ta’lim oluvchilar motivatsiyasi, mustaqil ta’lim olish ko‘nikmalari va o‘quv jarayonini tashkil etishga ta’siri o‘rganiladi. Shuningdek, innovatsion texnologiyalarni ta’lim jarayoniga integratsiya qilishda yuzaga keladigan muammolar aniqlanadi. Tahlil natijalari kompyuter texnologiyalari o‘quvchilarning fanga bo‘lgan qiziqishini oshirish, lug‘at boyligini mustahkamlash, o‘quv materiallarini interaktiv shaklda taqdim etish hamda tezkor qayta aloqa imkoniyatlarini kengaytirishga xizmat qilishini ko‘rsatadi. Shu bilan birga, texnik infratuzilmaning yetarli emasligi, mos dasturiy ta’minot tanqisligi, o‘qituvchilarning raqamli kompetensiyalari cheklanganligi va ta’lim oluvchilarda mustaqil o‘rganish ko‘nikmalarining yetarli darajada shakllanmaganligi asosiy muammolar sifatida qayd etiladi. Kompyuter texnologiyalaridan samarali foydalanish uchun pedagoglarning malakasini oshirish, zarur texnik sharoitlarni yaratish hamda raqamli vositalarni an’anaviy ta’lim metodlari bilan uyg‘unlashtirish zarurligi asosiy beriladi.

Kalit so‘zlar: kompyuterga asoslangan ta’lim, kompyuter yordamida til o‘qitish, ingliz tili, xorijiy til sifatida ingliz tili, innovatsion texnologiyalar, interaktiv multimedia, raqamli ta’lim.

Жавохирбек Толибджонов

Узбекский государственный университет мировых языков
Ташкент, Узбекистан

Научный руководитель: Нодира Кушиева – д.п.н., доцент

ИСПОЛЬЗОВАНИЕ ИННОВАЦИОННЫХ ТЕХНОЛОГИЙ В ПРЕПОДАВАНИИ АНГЛИЙСКОГО ЯЗЫКА (КОМПЬЮТЕРНОЕ ОБУЧЕНИЕ)

Аннотация. В статье рассматривается эффективность использования компьютерных технологий в преподавании английского языка как иностранного (EFL). Исследование основано на нарративном обзоре десяти научных публикаций, изданных в 2018–2025 годах. Анализ направлен на выявление влияния компьютерного обучения на мотивацию и самостоятельность учащихся, организацию учебного процесса, а также определение основных препятствий для интеграции цифровых технологий в языковое образование. Особое внимание уделяется интерактивным мультимедийным ресурсам, цифровым образовательным инструментам, автоматизированным системам контроля и возможностям оперативной обратной связи. Результаты обзора показывают, что применение компьютерных технологий способствует повышению учебной мотивации, развитию познавательного интереса, закреплению лексических навыков и активизации взаимодействия в аудитории. Вместе с тем установлено, что эффективность их использования зависит от технического оснащения образовательных учреждений, наличия соответствующего программного обеспечения, уровня цифровой компетентности преподавателей и способности учащихся самостоятельно организовывать обучение. Отмечается необходимость дальнейшего эмпирического изучения влияния компьютерных технологий непосредственно на результаты освоения английского языка. Обосновывается целесообразность интеграции цифровых образовательных средств с традиционными методами преподавания.

Ключевые слова: компьютерное обучение, компьютерно-опосредованное обучение языку, английский язык как иностранный, инновационные технологии, интерактивные мультимедийные средства, цифровое образование.

INTRODUCTION

Computer-based learning is teaching in which the computer serves as the main medium for presenting and practicing content through text, images, sound, animation and video [Xie, 2022]. In language teaching, the computer interacts with students and supplements conventional lessons to build language knowledge and train language skills [Bai, 2018; 225–231]. In a network environment, learners can also reach dictionaries, websites, video, audio and chat tools anytime and anywhere [Gao, 2021; 141–151].

The object of this review is computer-aided learning (CAL) in the teaching of English as a foreign language (EFL). The central concepts are computer-based learning, computer-assisted language learning (CALL) and interactive multimedia, which in this article denote teaching in which computers, software and network resources are used to present content, give practice and provide feedback. The topic matters for EFL, where students have limited chances to practice and evaluate their skills [Zhang, 2022]. Technology can raise engagement, provide authentic language input and support collaborative language learning [Zhang, 2022]. Computer-aided instruction also increases students' interest and initiative and allows personalized learning [Gao, 2021; 141–151].

The EFL classroom is the main place where English is taught, practiced and assessed, yet traditional teaching often leaves students passive and uninterested [Gao, 2021; 141–151]. Computer-aided learning changes this by turning the teacher into an organizer and facilitator and students into active participants [Gao, 2021; 141–151]. Teachers are the main actors in using technology every day, so they need continuing professional development [Zhang, 2022]. Technology is only an auxiliary means, and successful classrooms depend on hardware, software and trained teachers together [Bai, 2018; 225–231].

Research from other subjects supports these ideas. Simulations improved students' chemistry marks and motivation [Nsabayezu et al., 2023; 3537–3555], and teachers were found to underuse interactive media although students supported it [Roemintoyo et al., 2022; 105–119]. Learners also need self-regulation skills to benefit from computer-based tasks [Torrington et al., 2024; 231–258] [Aksela et al., 2025; 1727–1756]. Within EFL, the reported results are encouraging: in one study, composition errors in the class using computer-aided instruction fell from 194 to 97, and its average score rose from 58.6 to 69.6 [Xie, 2022].

However, evidence specific to EFL is limited. Four of the reviewed sources deal directly with English teaching, but only one of them, the study by Xie, reports measured English outcomes, and it does not give the sample size or statistical tests [Xie, 2022]. The other three are conceptual. This leaves open whether the benefits described in the English-focused papers are confirmed by data, whether findings from chemistry, biology and general education can be applied to English classes, and which conditions decide whether CAL succeeds. These questions matter for teachers and institutions that must decide how to invest in equipment, software and training.

The aim of this article is to review recent studies on the effectiveness of computer-aided learning in EFL classrooms. It has three tasks: to identify the effects of CAL on EFL students, its effects on the classroom, and the challenges that limit its integration. The article makes three contributions. It separates the English-specific evidence from evidence drawn from other subjects, it compares what each type of source can and cannot show, and it brings together the conditions that the sources identify as decisive for success. The main finding is that CAL is valued for increasing motivation and giving authentic, flexible practice, but direct evidence of improved English achievement is still limited. The article follows the IMRaD structure: the Methods section describes the corpus, the Results section presents the findings in three tables together with a comparative analysis, the Discussion evaluates them, and the Conclusion answers the research questions.

METHODS

This article is a narrative review of ten recent journal articles (2018–2025) on computer-aided and computer-based learning. A narrative

design was chosen because the sources differ greatly in purpose and method: they include conceptual papers, controlled comparisons, media development studies, perception studies and studies of learner behaviour, which cannot be combined statistically.

Four of the sources deal directly with English teaching [Zhang, 2022] [Xie, 2022] [Bai, 2018; 225–231] [Gao, 2021; 141–151]. Six come from other subjects and general education [Harahap & Nasution, 2022; 31–45] [Roemintoyo et al., 2022; 105–119] [Nsabayezu et al., 2022; 11267–11284] [Nsabayezu et al., 2023; 3537–3555] [Torrington et al., 2024; 231–258] [Aksela et al., 2025; 1727–1756]. No new data were collected: the data are the published reports of the ten studies. Three of the ten sources were read from their abstracts only, which limits the detail available for them. Table 1 lists the sources. Each article was summarized by aim, method, findings and limitations, and then grouped into themes. The research gap that guided the review is that only one source reports measured English learning outcomes [Xie, 2022]. The review asks three research questions:

(1) What effects does computer-aided learning have on EFL students?

(2) What effects does it have on the classroom?

(3) What challenges limit its integration?

The findings are reported by question in the Results section. Table 2 compares the evidence on learning outcomes and product ratings, and Table 3 compares the challenges identified in the sources.

RESULTS

Effects of CAL on EFL students (research question 1)

Three sources discuss computer-aided learning in English teaching at the conceptual level, and two studies compare groups to measure learning outcomes. Table 2 sets out the evidence on outcomes and product ratings.

Zhang reviewed the literature because technology-focused professional development was scarce in China [Zhang, 2022]. The review concludes that technology increases engagement and gives EFL learners authentic language practice. Gao argued that traditional college English teaching is teacher-centered and leaves students passive [Gao, 2021; 141–151].

Table 1.

Sources included in the review

Source	What was done	Contribution to CAL
Zhang, 2022	Conceptual review of technology and teacher professional development in EFL	Technology benefits EFL engagement; teachers need training to use it
Bai, 2018	Conceptual paper on integrating CALL facilities into college English	Integration principles and tools; limits for writing and speaking
Gao, 2021	Conceptual paper on computer-aided instruction in college English	Advantages and barriers (funding, software, teacher skills)
Xie, 2022	Experimental and control classes using computer-based vocabulary and writing practice	Fewer composition errors and higher scores; evidence limited
Harahap & Nasution, 2022	Developed and expert-validated computer-based media (biology)	Indirect: how media are developed and validated
Roemintoyo et al., 2022	Developed interactive multimedia; rated by experts, teachers and students (vocational education)	Indirect: teachers underuse ICT media; students support interactive multimedia
Nsabayezu et al., 2022	Teacher survey and student interviews on computers in chemistry for students with disabilities	Indirect: inclusion benefits; lack of equipment and training

Nsabayezu et al., 2023	Simulation group and control group with tests and interviews (chemistry)	Indirect: computer-based tools raised marks and motivation
Torrington et al., 2024	Compared self-regulation measures among 48 elementary students	Indirect: self-regulation knowledge predicts computer task performance
Aksela et al., 2025	Trace data and interviews of students in a computer-based writing task	Indirect: successful writers regulate time and monitoring differently

The author lists advantages of computer-aided instruction, such as flexible access, personalized learning and authentic language exposure.

Bai examined how computer-assisted language learning facilities can be integrated into college English courses [Bai, 2018; 225–231]. The paper describes question banks, courseware and online tests that give immediate feedback, and proposes four integration principles: autonomy, induced interest, integrity and aptitude.

Xie wanted to solve the lack of flexibility and student interest in English courses [Xie, 2022]. One class used a computer system that tested vocabulary, showed incorrect words and repeated them until learned, while a control class followed traditional teaching. After a semester, composition errors in the experimental class fell from 194 to 97, compared with 116 in the control class, and its average score rose from 58.6 to 69.6, against 50.2 to 51.3. However, the paper does not report sample size or statistical tests. It is therefore the only measured evidence on English outcomes in the corpus, and its reporting is incomplete.

Nsabayezu et al. tested computer-based simulations because organic chemistry is abstract and difficult [Nsabayezu et al., 2023; 3537–3555]. They taught 36 students with simulations and 36 without, using pre- and post-tests and interviews with 20 students. The simulation group scored much higher and reported more motivation and understanding. This study is better documented than Xie's, but it concerns chemistry, so it supports the general idea that computer-based tools can raise marks and motivation rather than any English-specific effect.

Table 2.

Evidence on learning outcomes and product ratings

Study	Sample or raters	Reported result	Limitation
Xie, 2022 (English)	Experimental and control classes	Errors 194 to 97 (control 116); mean score 58.6 to 69.6 (control 50.2 to 51.3)	Sample size and statistical tests not reported
Nsabayezu et al., 2023 (chemistry)	36 simulation and 36 control students; 20 interviewed	Simulation group scored much higher; more motivation and understanding	Not an English study
Harahap & Nasution, 2022 (biology)	Two experts	Product rated 89% to 100%	No learning gains measured
Roemintoyo et al., 2022 (vocational)	Experts, teachers, 54 students	Product rated appropriate	No learning gains measured

Effects of CAL on the classroom (research question 2)

The English-focused papers describe the classroom effect mainly as a change in roles and interaction. Gao presents the teacher as an organizer and facilitator rather than the only source of knowledge, with students becoming active participants [Gao, 2021; 141–151]. The question banks, courseware and online tests described by Bai give immediate feedback [Bai, 2018; 225–231], and Zhang reports that technology raises engagement [Zhang, 2022].

Three studies focused on developing computer-based media and on perceptions of it. Harahap and Nasution developed Flash-based media for an ecosystem topic because many students failed it and teachers rarely used interactive media; two experts rated the product between 89% and 100% [Harahap & Nasution, 2022; 31–45]. Roemintoyo et al. developed interactive multimedia for vocational students after finding that teachers used ICT media poorly, and experts, teachers and 54 students rated it appropriate [Roemintoyo et al., 2022; 105–119]. Nsabayezu et al. surveyed 15 chemistry teachers and interviewed 10 students with hearing or visual disabilities, and participants perceived computers as effective, although too few adapted computers and too little teacher training were reported [Nsabayezu et al., 2022; 11267–11284]. These studies show that products can be validated and are welcomed, but they do not measure learning gains.

Challenges limiting integration (research question 3)

The sources identify challenges at three levels: the school, the teacher and the learner (Table 3). At school level, Gao identifies lack of funds and unsuitable software [Gao, 2021; 141–151], and Nsabayezu et al. report too few adapted computers [Nsabayezu et al., 2022; 11267–11284]. At teacher level, Zhang found that teachers hesitate to use technology because of technical problems and low confidence, so they need continuing training [Zhang, 2022]. Gao adds teachers' limited knowledge and reluctance to change [Gao, 2021; 141–151], and Roemintoyo et al. found that teachers underused interactive media although students supported it [Roemintoyo et al., 2022; 105–119]. Bai also notes that computer-aided teaching seems less effective for writing and speaking [Bai, 2018; 225–231].

At learner level, two studies examined the learner's role. Torrington et al. compared four ways of measuring self-regulation among 48 elementary students, and only students' written explanations of strategies predicted task performance [Torrington et al., 2024; 231–258]. Aksela et al. combined digital trace data and interviews with 42 secondary students writing on a computer, and successful writers differed in time allocation, transitions between processes and monitoring [Aksela et al., 2025; 1727–1756]. Both suggest that students need self-regulation skills to benefit from computer-based tasks, although neither was conducted in an EFL classroom.

Comparison across the sources

The sources are not fully consistent. Bai notes that computer-aided teaching seems less effective for writing and speaking [Bai, 2018; 225–231], whereas Xie reports gains in writing [Xie, 2022]. The two papers are of different kinds: Bai's is a conceptual paper on CALL facilities, while Xie's is a classroom comparison, but Xie's lack of reported sample size and statistical tests prevents a firm conclusion. More generally, the strength of evidence differs by source type. The conceptual papers describe benefits and barriers, the development studies show validity and acceptance, the two group comparisons measure marks, and only one of these concerns English. Table 2 shows this pattern: the two rows with learning results have a comparison group, while the two rows with product ratings show acceptance only. The strongest agreement across all ten sources is therefore about motivation, engagement and the conditions needed for success, and the weakest is about English achievement.

Table 3.

Challenges limiting the integration of CAL

Level	Source	Challenge reported
School	Gao, 2021; Nsabayezu et al., 2022	Lack of funds; unsuitable software; too few adapted computers
Teacher	Zhang, 2022; Gao, 2021	Technical problems, low confidence, limited knowledge, reluctance to change
Teacher	Roemintoyo et al., 2022; Nsabayezu et al., 2022	Underuse or poor use of ICT media; too little training

Skills taught	Bai, 2018	Computer-aided teaching seems less effective for writing and speaking
Learner	Torrington et al., 2024; Aksela et al., 2025	Self-regulation needed to benefit from computer-based tasks

DISCUSSION

Interpretation of the findings

The reviewed studies agree that CAL can make EFL teaching more engaging, flexible and personalized, but the strength of the evidence varies. The English-focused papers describe benefits such as greater motivation, authentic language input, immediate feedback and richer classroom interaction [Bai, 2018; 225–231] [Gao, 2021; 141–151] [Zhang, 2022], and they present the teacher as an organizer and facilitator rather than the only source of knowledge [Gao, 2021; 141–151]. Only Xie measured English learning outcomes, reporting fewer composition errors and higher scores in the computer-aided class, but the paper does not provide the sample size or statistical tests, so its results should be treated cautiously [Xie, 2022].

Studies from other subjects point the same way: simulations raised students' marks and motivation in chemistry [Nsabayezu et al., 2023; 3537–3555], and teachers and students saw computers as useful in inclusive classrooms [Nsabayezu et al., 2022; 11267–11284]. The two development studies show that interactive media can be validated and are welcomed by students, yet neither measured learning gains [Harahap & Nasution, 2022; 31–45] [Roemintoyo et al., 2022; 105–119]. The answer to the first research question is therefore stronger for motivation and engagement than for English achievement. The findings are also not fully consistent, since Bai notes that computer-aided teaching seems less effective for writing and speaking, while Xie reports gains in writing.

Evaluation and implications

The reviewed studies also show that the effect of CAL depends on conditions around the technology. Teachers need continuing training and confidence [Zhang, 2022], schools need funds, equipment and suitable software [Gao, 2021; 141–151] [Nsabayezu et al., 2022; 11267–11284], and teachers were found to underuse ICT media even where students supported it [Roemintoyo et al., 2022; 105–119]. Bai stresses that technology is an auxiliary means and that traditional teaching still has value [Bai, 2018; 225–231]. Learners also matter: students' ability to explain and manage their strategies predicted performance in computer-based tasks [Torrington et al., 2024; 231–258], and successful writers monitored and allocated their time differently [Aksela et al., 2025; 1727–1756]. These two studies were not conducted in EFL classrooms, so their application to English learning is an assumption that needs testing.

Three practical implications follow, each stated cautiously because of the limited evidence. First, institutions that introduce CAL should plan for equipment, suitable software and teacher training together, since the sources treat these as a package. Second, teachers can use CAL for the features the sources describe, such as immediate feedback, repeated practice of incorrectly answered items and flexible access, while checking carefully how it affects writing and speaking, where the sources differ. Third, learners may need support in planning and monitoring their work, because self-regulation appears to affect success in computer-based tasks.

These implications apply most directly to contexts such as the college English courses described by Bai and Gao [Bai, 2018; 225–231] [Gao, 2021; 141–151], and they should be adapted to local resources, because the sources show that equipment, software and training differ widely between schools.

The findings also help to evaluate the assumption, common in the English-focused papers, that CAL makes learners more autonomous and interested [Gao, 2021; 141–151]. This assumption is supported by descriptions and by studies from other subjects, such as the higher motivation reported in the chemistry simulation group [Nsabayezu et al., 2023; 3537–3555], but it has not been tested with English learners using measures of motivation. For this reason the claims about autonomy and interest should be read as plausible rather than proven for EFL.

Limitations and recommendations

This review has further limitations: it is narrative, it includes only ten sources, six of them from other subjects, and three were read from abstracts only. Future research should therefore use controlled designs with clear samples in EFL classrooms and examine how teacher training and learner self-regulation shape the results.

CONCLUSION

This review set out to examine the effects of computer-aided learning in EFL classrooms, and the three research questions posed in the Introduction can now be answered.

Regarding the first question, CAL is considered a valuable support for EFL students, mainly because it increases motivation and interest, offers authentic and flexible practice and supports vocabulary retention; the only measured English result, a reduction in composition errors, comes from a study with incomplete reporting. Regarding the second, CAL changes the classroom toward more active, interactive and personalized learning, with the teacher acting as organizer and facilitator. Regarding the third, integration is limited by funding and infrastructure, a shortage of suitable software, insufficient teacher training and reluctance to change, and learners' difficulty regulating their own learning in digital environments.

Direct evidence of improved English achievement is therefore still limited, since only one reviewed study measured it, and success depends on teacher training, adequate resources, suitable software and learners' self-regulation. CAL should be used to complement, not replace, traditional teaching, and more rigorous EFL-specific studies are needed.

REFERENCES

1. Aksela, O., Lämsä, J., & Järvelä, S. (2025). Secondary school students' enacted self-regulated learning strategies in a computer-based writing task: Insights from digital trace data and interviews. *Technology, Knowledge and Learning, 30*(3), 1727–1756. https://doi.org/10.1007/s10758-024-09789-4
2. Bai, Y. (2018). On modern computer assisted language learning facilities and its integrated teaching. *International Journal of Emerging Technologies in Learning (iJET), 13*(11), 225–231. https://doi.org/10.3991/ijet.v13i11.8542
3. Gao, Y. (2021). Computer-aided instruction in college English teaching under the network environment. *Computer-Aided Design & Applications, 18*(S4), 141–151. https://doi.org/10.14733/cadaps.2021.S4.141-151
4. Harahap, M. P., & Nasution, N. E. A. (2022). Validity of computer based learning media to improve junior high school students' learning outcomes on ecosystem topics. *META: Journal of Science and Technological Education, 1*(1), 31–45. https://meta.amiin.or.id/index.php/meta/article/view/3
5. Nsabayezu, E., Iyamuremye, A., Urengejeho, V., Mukiza, J., Ukobizaba, F., Mbonyiryivuze, A., & Kwitonda, J. D. D. (2022). Computer-based learning to enhance chemistry instruction in the inclusive classroom: Teachers' and students' perceptions. *Education and Information Technologies, 27*(8), 11267–11284. https://doi.org/10.1007/s10639-022-11082-9
6. Nsabayezu, E., Iyamuremye, A., Mukiza, J., Mbonyiryivuze, A., Gakuba, E., Niyonzima, F. N., & Nsengimana, T. (2023). Impact of computer-based simulations on students' learning of organic chemistry in the selected secondary schools of Gicumbi District in Rwanda. *Education and Information Technologies, 28*(3), 3537–3555.
7. Roemintoyo, R., Miyono, N., Murniati, N. A. N., & Budiarto, M. K. (2022). Optimising the utilisation of computer-based technology through interactive multimedia for entrepreneurship learning. *Cypriot Journal of Educational Sciences, 17*(1), 105–119.
8. Torrington, J., Bower, M., & Burns, E. C. (2024). Elementary students' self-regulation in computer-based learning environments: How do self-report measures, observations and

teacher rating relate to task performance? *British Journal of Educational Technology, 55*(1), 231–258.

9. Xie, C. (2022). Effectiveness of computer-aided technology for teaching English courses in the Internet era. *Scientific Programming, 2022*(1), Article 2133028. https://doi.org/10.1155/2022/2133028
10. Zhang, W. (2022). The role of technology-based education and teacher professional development in English as a foreign language classes. *Frontiers in Psychology, 13*, Article 910315. https://doi.org/10.3389/fpsyg.2022.910315