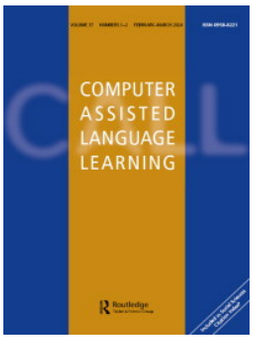

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Vocabulary learning strategies in extramural English gaming and their relationship with vocabulary knowledge

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ABSTRACT

Research has shown that students learning English as a foreign language can enhance their vocabulary knowledge through exposure to the target language outside of school. However, little is known about whether certain extramural activities have stronger links with vocabulary acquisition than others, and more crucially, the extent to which the vocabulary learning strategies that learners employ during extramural English encounters affect vocabulary learning outcomes. The study reported in this article investigated the relationship between the vocabulary learning strategies employed by 116 students in a Norwegian secondary school when gaming extramurally in English, their gaming frequency, engagement in other EE activities besides gaming, and their receptive and productive English vocabulary knowledge. The findings revealed that inferencing, using language references, and notetaking when gaming statistically significantly correlated with participants' productive vocabulary knowledge, whereas only inferencing predicted their receptive vocabulary knowledge. Moreover, a negative link was discovered between playing driving games and receptive vocabulary knowledge.

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Extramural English; English as a foreign language; vocabulary knowledge; gaming; learning strategies

1. Introduction

In the dynamic landscape of foreign language education in the twenty-first century, where learning often transcends the classroom's physical boundaries, extramural language exposure can be a bridge connecting formal

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language instruction with real-world language use. For educators, such learning holds significant potential, if harnessed effectively (Calafato & Gudim, 2022), with respect to students' scholastic achievement because it represents a place beyond the confines of textbooks and lesson plans where students hone their language skills, forge cultural connections, and develop their ability to engage in authentic communication. By embarking on an exploration of how learners engage in extramural activities involving the target language, the language skills they use when doing so, and whether they implement specific learning strategies during these encounters, educators can obtain a more holistic perspective on their linguistic development, one that embraces diverse contexts, interactions, and experiences (Calafato, 2023; Rød & Calafato, 2024). One language that has received the bulk of attention in this regard has been English, which is understandable given its status as a global lingua franca. Dubbed extramural English (EE) by some and defined as the informal and typically voluntary use of English by learners in both online and offline environments beyond the traditional classroom setting (Sundqvist & Sylvén, 2016), these encounters have been shown to correlate, if not always strongly, with overall language proficiency, including vocabulary knowledge and reading skills (Brevik, 2016; Rød & Calafato, 2023; Sundqvist & Wikström, 2015), motivation (Leona et al., 2021), willingness to communicate (Lee & Lu, 2023), and anxiety (Uztosun & Kök, 2023).

In theoretical terms, the positive links between EE, cognition, affect, and language learning outcomes can be understood through the prism of social cognitive theory (Bandura, 1986), with its emphasis on learning through observation, self-efficacy, self-regulation, and the reciprocal and dynamic nature of interactions that occur between personal and environmental factors. For instance, EE provides opportunities for learners to gradually build confidence in their English language skills and allows them to monitor their progress, set goals, and adapt learning strategies based on their experiences, thereby enhancing their feelings of self-efficacy and ultimately leading to better learning outcomes. This is especially true for gaming, a unique extramural activity due to its combination of contextual learning, trial-and-error format, scaffolded interactions, and customization, during which learners receive instantaneous and continuous feedback on their actions in relation to game content (Reinhardt, 2018; Ryu, 2013). In contrast, other popular extramural activities, such as watching TV, reading books, or listening to music, are generally more passive in design, do not provide the same level of scaffolded interaction and feedback, and can negatively impact learning outcomes (De Wilde et al., 2020; Rød & Calafato, 2023). Gaming also requires learners to observe how in-game characters and other players use the target

language in diverse contexts, thereby improving their ability to anticipate outcomes based on their chosen course of action, enriching their understanding of language use, and providing them with multiple language models on which to draw.

Studies on the links between gaming and language learning outcomes have primarily investigated correlations between gaming *frequency* and English proficiency (generally vocabulary), with the findings indicating a positive, if not always practically significant, relationship (Rød & Calafato, 2024). For instance, Jensen (2017), in their study of 107 EFL (English as a foreign language) learners in Denmark, found that while gaming with oral and written English input positively predicted receptive vocabulary knowledge, the correlations were mostly weak (tau values of between .20 and .40; for interpreting effect sizes, see Plonsky & Oswald, 2014). Sundqvist and Wikström (2015), examining the links between gaming and language proficiency, discovered that eighth- and ninth-grade learners from Swedish schools who were frequent gamers had higher vocabulary scores, with the effect size being quite large (e.g. $\eta^2 = .22$). At the same time, differences in educational achievement (e.g. exam scores or final grades), depending on gaming frequency, were either not significant or weak. Somewhat similarly, Puimège and Peters (2019), using a questionnaire to collect data on 616 Flemish children and their EE activities, noticed a positive relationship between gaming and video streaming and word knowledge based on age and frequency of engagement. They observed that older participants who engaged in gaming and video streaming tended to have better meaning recognition, while the frequency of gaming and video streaming directly and positively correlated with meaning recall (yet had a small effect size: Cohen's $d = .20$). Warnby (2022), meanwhile, examined the extent to which different EE activities (e.g. watching TV, reading fiction, etc.) correlated with academic vocabulary in 817 EF learners born in 2002 and 2003. The researcher found that there was a weak, positive correlation between gaming and academic vocabulary overall ($r = .25$).

Given the number of studies on EE frequency and learning outcomes, one can conclude that there is sufficient evidence that the two are positively correlated, if not always meaningfully (i.e. when considering effect size; for a review, see Zhang et al., 2021). However, while the effects of EE frequency, including for different extramural activities (i.e. reading books versus watching film) have been studied, little is known about how learners engage with the language during such encounters (Bytheway, 2015; Reinhardt & Han, 2021). For example, whether they use particular vocabulary learning strategies (VLS) when exposed to new words or expressions, and, more crucially, if certain strategies more strongly predict successful learning outcomes than others. Indeed, delving into the

specific strategies learners employ during EE could shed greater light on the mechanisms that contribute to successful language learning through EE and help educators more effectively bridge the gap between classroom teaching and real-world language use. This study set out to contribute to our understanding of learner behaviour during EE by examining the relationship between the VLS that learners of English as a foreign language in a Norwegian school reported using when gaming extramurally, their gaming frequency (per game genre), their engagement in other types of EE activities (i.e. beyond gaming), and their receptive and productive English vocabulary knowledge. Ultimately, any EE encounter can introduce learners of English to unfamiliar words and expressions, requiring them to process and adapt to this new linguistic input, for which they may employ various strategies as they seek to incorporate it into their growing language repertoire.

2. Extramural English and language learning when gaming

While social cognitive theory (Bandura, 1986) helps us to understand the relationship between EE, cognition, affect, and language learning outcomes, the EE phenomenon itself is rather complex and draws from other theoretical frameworks besides, for example, the output (Swain, 2006) and interaction (Long, 1981) hypotheses. The output hypothesis suggests that learners become aware of gaps in their linguistic knowledge and modify their language output to address these gaps. Interactionist approaches, meanwhile, stress the role of interaction in language acquisition, as learners actively use language to negotiate meaning and co-construct knowledge. EE aligns with these theories as learners engage in authentic communicative interactions extramurally, such as when gaming, where they encounter opportunities to practice and adapt their language based on feedback (Ibrahim, 2022; Ng et al., 2022; Reinhardt & Han, 2021). The relationship between computer or video gaming (referred to as 'gaming' in this study) and language learning has garnered significant attention from researchers in the last decade (Jabbari & Eslami, 2019; Xu et al., 2020), extending beyond in-game engagement to encompass beyond-game interactions among players that enrich their gameplay through discussions and collaboration in online communities. Note that games are produced worldwide in multiple languages, leading some players to play games in languages that they do not know (or do not know well) simply because the game is not available in their native language. Others who speak the game's language may choose to play in a different language to practice or learn it, recognizing such an opportunity as a valuable resource (Vazquez-Calvo, 2018).

During gaming, language learning can occur when learners interact with native or more proficient speakers or game content in the target language (Pasfield-Neofitou, 2014). Nardi et al. (2007), focusing on how players learned to play World of Warcraft through chat conversations with other players, discovered that language learning through gaming was spontaneous and contextual. Thorne (2008), analysing in-game and game-related interactions between English and Russian speakers in World of Warcraft, reported that participants engaged in various language learning activities, forming supportive relationships that encouraged collaboration for language learning (see also Rama et al., 2012). However, as Heidt et al. (2023) note, there is a limited understanding of *how* language, including vocabulary, is learned during gaming. Language learning strategies (LLS) are a critical area of study in the realm of foreign language acquisition because they offer concrete ways for learners to improve their language skills (Oxford, 2017; Pawlak, 2021). While some scholars, notably Dörnyei and colleagues (Dörnyei & Ryan, 2015; Dörnyei & Skehan, 2003), have questioned the theoretical underpinnings of LLS and suggested replacing the term 'strategy' with 'self-regulation', these criticisms are not without their counterarguments (Griffiths, 2020; Oxford, 2017). LLS are dynamic, conscious thoughts and actions employed by learners to regulate various aspects of themselves (Oxford, 2017). VLS constitute a specialized LLS subset encompassing both direct and indirect processes, aiding in word acquisition, storage, retrieval, encoding, rehearsal, and practical usage.

Researchers have categorized VLS strategies based on when they are employed and their roles in different aspects of language learning (Bytheway, 2015; Gu, 2018; Yu et al., 2023). Successful language learners (and gamers) tend to use specific VLS, employing them flexibly and adaptively to suit different situations, though it is important to note that studies in this area are few, having mostly focused on massively multiplayer online role-playing games (MMORPGs) and relied on small participant samples (e.g. Nardi et al., 2007; Ng et al., 2022; Rama et al., 2012; Smith et al., 2013). Furthermore, these studies did not generally investigate the extent to which VLS use was related to vocabulary learning outcomes. For example, Ng et al. (2022), in their study of VLS use by intermediate EFL learners when playing MMORPGs, found that participants predominantly utilized cognitive and memory strategies during gaming and relied the least on activation and metacognitive strategies. The researchers observed that participants' VLS were influenced by factors such as the game's storyline and social interactions, though the study did not explore how participants' VLS use impacted their vocabulary knowledge. Similarly, in her study of how in-game culture influenced the VLS of six EFL learners at university, Bytheway (2014) discovered that participants, who were all male and

regularly played MMORPGs alongside other online games, were positively affected by the social environment in MMORPGs. The researcher noted participants primarily employed cognitive strategies, such as looking up words in a dictionary or online, visualization techniques (linking an image to a word), and relying on context.

2.1. Research questions

Given the limited overall research conducted on how learners of English engage with the language during extramural encounters and the extent to which the learning strategies they employ in such encounters predict their learning outcomes, this study sought answers to the following questions:

1. What vocabulary learning strategies do the participants report most relying on during gaming extramurally in English?
2. To what extent do their reported vocabulary learning strategies while gaming, alongside their engagement in other extramural activities and gaming frequency, predict their vocabulary knowledge?

3. Methods

3.1. Participants and data collection procedure

One hundred and sixteen participants (male = 55, female = 58, and other = 3) were recruited from six classes at a secondary school in southern Norway where one of the researchers was employed as a substitute teacher. The participants were well acquainted with the researcher and were studying in Grades 8, 9, and 10 (two classes from each grade participated in the study). Data for the study were collected via an online questionnaire and receptive and productive vocabulary tests. These were administered on the same day to participants during English class, which has a duration of 90 min at the school. One of the researchers was present during data collection to answer any questions from students and help resolve any issues that might arise. The participants first completed the receptive and productive vocabulary tests, with 30 min allotted for this task. They were then given an additional hour to answer the questionnaire. Before commencing the questionnaire and tests, we conducted a brief review of the questionnaire items with the students to ensure their comprehension. In the weeks leading up to data collection, we had already discussed the research project's objectives with them and emphasized that participation was voluntary,

anonymous, and would not have any adverse impact on their studies. The questionnaire consisted of 63 items, including 11 questions about the frequency of participants' weekly gaming in English across different game genres (e.g. strategy, adventure, and role-playing). It also asked them about their weekly passive (12 items) and active (i.e. where they produced language; eight items) extramural exposure to YouTube, films, TV shows, Twitch, other streaming platforms, blogs, and social media. These questions all used a 6-point Likert scale, with values ranging from 'not at all', '1–4 h', '5–10 h', '11–15 h', '16–24 h', to 'more than 24 h' weekly.

A 19-item VLS scale, developed from Gu's (2018) 62-item measure was also included in the questionnaire. The measure employs a 7-point Likert scale ranging from 'strongly disagree' to 'strongly agree'. The number of items in Gu's questionnaire was reduced following a piloting stage with 41 students. Their feedback indicated that the 62-item questionnaire was too large and that many of the items were not relevant to vocabulary learning when gaming. Specifically, concerns were raised about the items belonging to the 'beliefs about vocabulary learning' category and the 'self-initiation' component of the 'metacognitive strategies' category, and these were removed. Following the completion of the final questionnaire by the 116 participants, exploratory factor analysis (EFA) using principal axis factoring (PAF) and oblimin rotation was conducted, and Bayesian Information Criterion (BIC) scores were used to select the number of factors (Preacher et al., 2013). Items with factor loadings of less than .30 were discarded during EFA, leading to a 19-item measure that loaded onto five factors (see Table 1) and explained 67.00% of the variance. Kaiser–Meyer–Olkin (KMO) (.90 for the overall scale; for individual items, see Table 1) and Bartlett's test of sphericity values (χ^2 = 1500.03, df=171, p < .001) indicated that the sample used was adequate for factor analysis. Goodness-of-fit values revealed that the five-factor model provided a good fit for the data (BIC=−263.18, RMSEA = .05, TLI = .98), and reliability scores, reported in the form of Cronbach's alpha (α) and McDonald's omega (ω) coefficients, indicated satisfactory internal consistency for each of the five factors.

Factor 1 (a = .88, ω = .88) contained strategies that could be categorized as primarily *rehearsal* strategies, while those comprising Factor 5 (a = .86, ω = .85) involved *visualization* techniques. Strategies loading onto Factor 2 (a = .89, ω = .89) focused on *inferencing* based on context, whereas those making up Factor 3 (a = .87, ω = .87) were concerned with *the use of language references*, such as dictionaries. As for Factor 4 (a = .86, ω = .86), it grouped *notetaking* strategies. The two tests that the participants completed were the V_YesNo v1.0 (Meara & Miralpeix, 2016) for receptive vocabulary knowledge, and the Lex30 (Meara & Fitzpatrick, 2000) for productive vocabulary knowledge. The V_YesNo

Table 1. Factor loadings and reliability coefficients for the 19-item VLS scale.

	Factors						
When gaming…	1	2	3	4	5	Uq.	MSA
15. I try to use the newly learned words as much as possible in my speech and writing.	.79	.04	−.02	.16	−.04	.26	.90
16. I regularly review the new words I have learned (e.g., mentally or via word lists).	.72	−.01	.06	−.05	.13	.36	.89
14. I try to use newly learned words in everyday situations.	.70	.08	.02	.07	.09	.32	.94
11. When I try to remember a word, I say it out loud to myself.	.70	−.11	.02	.07	.00	.49	.88
17. I focus on how words are formed to remember them more effectively.	.45	.05	.14	.05	.17	.54	.94
13. When I try to remember a word, I also try to remember the sentence the word is used in.	.45	.18	.04	−.09	.32	.46	.93
1. I know if a new word is important to help me understand the game.	.17	.78	.08	−.02	−.16	.33	.86
2. I know which words are important for me to progress in the game.	.03	.86	.03	−.11	−.05	.32	.87
3. I use context when guessing the meaning of a word.	.01	.55	.00	.17	.23	.41	.92
4. I use my knowledge of the world when guessing the meaning of a word.	−.10	.47	.07	.19	.30	.43	.90
5. I look for explanations in the game world that support my guess about the meaning of a new word.	−.12	.84	−.01	.13	.12	.16	.89
6. I look up unfamiliar words (e.g., online dictionary, translator, etc.) that are important for understanding the game.	.00	.10	.59	.18	.02	.42	.89
7. When I want to know more about the usage of a word I know from the game, I look it up.	.00	.00	1.05	−.01	.00	−.09	.89
8. I take notes when I believe the word that I'm looking up relates to my interests.	−.03	.07	.33	.54	.04	.35	.91
9. I take notes when I come across a useful expression or phrase.	.17	.10	.04	.74	−.07	.24	.91
10. I note down both the meaning in my native language and the English explanation of the word I look up.	.09	−.04	.06	.71	.11	.33	.93
12. I try to use newly learned words in imaginary situations.	.26	.01	.15	−.11	.64	.28	.87
18. I try to remember new words by associating them with words I know.	.25	.13	−.05	.18	.50	.35	.91
19. I create a mental image to help me remember new words.	.04	.01	.09	.10	.70	.33	.87

Note: Uq.: uniqueness; MSA: Measure of Sampling Adequacy (Kaiser–Meyer–Olkin statistic).

v1.0 is scored out of 10,000 points, whereas the Lex30 has a maximum score of 120.

3.2. Data analysis

Data from the questionnaire were analysed in JASP and SPSS. Exploratory factor analysis was performed to identify and extract underlying latent factors within the dataset (see Section 3.1.). A paired sample t-test was conducted to ascertain whether differences in participants' engagement in EE activities other than gaming where they used their productive versus receptive language skills were statistically significant. A repeated measures ANOVA was conducted to examine differences in participants' reported use of VLS when gaming (i.e., whether some strategies were preferred over others). Finally, multivariate regression was performed to understand the extent to which participants' receptive and productive vocabulary knowledge, as measured by the V_YesNo v1.0 and Lex30 tests, were predicted by their VLS when gaming, weekly gaming frequency (per game genre), gender and engagement in EE activities other

than gaming where they produced (or did not produce) English. The data were checked for autocorrelation, multicollinearity, sphericity, and outliers when conducting the statistical tests. Effect size is reported via Cohen's *d* for the paired t-test (correlations were taken into account when calculating effect size) and partial eta-squared (η_p^2) for the regression and repeated measures ANOVA, as is observed power ($1-\beta$). Cohen's *d* was interpreted using the recommendations made by Plonsky and Oswald (Plonsky & Oswald, 2014), while we used the benchmarks suggested by Cohen (1969) for η_p^2 (note that there remain issues when interpreting partial eta-squared; see Norouzian & Plonsky, 2018). An alpha level of .05 was implemented for all significance testing.

4. Findings

Table 2 contains descriptive statistics for participants' reported weekly gaming frequency based on game genres (see Section 3.1.). Overall, the data indicated that participants did not heavily engage in gaming and spent more time on strategy, sport, shooter, and sandbox survival games than on multiplayer online battle arena (MOBA), platformers, or role-playing games. Participants' responses regarding their engagement in EE activities besides gaming (see Section 3.1.) revealed that their passive exposure to English ($M = 1.99$, SD = .56) was much more frequent than productive engagement ($M = 1.29$, SD = .58), with the difference between their passive and active exposure being statistically significant according to paired sample *t*-test results [$t(115) = 16.06$, $p < .001$, $d = 1.52$, $1-\beta = 1.00$].

On average, participants scored 4634.89 (SD = 1928.47) on the V_YesNo v1.0 test and 71.09 ($SD = 34.96$) on the Lex30 test, indicating that they had an intermediate level of English (Meara & Miralpeix, 2016; Walters, 2012). Table 3 presents descriptive statistics regarding participants' reported use of VLS when gaming (see Section 3.1.). The data suggested that inferencing was the most preferred method for learning

Table 2. Weekly gaming frequency in English per game genre as reported by participants.

Genre	*M*	SD
Shooter	1.92	1.35
Sport	1.71	1.17
Sandbox Survival	1.65	1.04
Strategy	1.62	0.89
Driving	1.59	0.92
Adventure	1.53	1.02
Puzzle	1.35	0.66
Party	1.34	0.66
RPG	1.26	0.69
Platformer	1.22	0.69
MOBA	1.10	0.41

Note: MOBA: multiplayer online battle arena; RPG: role-playing game.

Table 3. Participants' reported vocabulary learning strategies when gaming.

Vocabulary learning strategies	*M*	SD
Inferencing	4.42	1.66
Visualisation	3.64	1.66
Language references	3.50	1.88
Rehearsal	3.41	1.40
Notetaking	3.19	1.61

vocabulary when gaming, followed by visualization in second place, whereas notetaking was the least popular.

A repeated measures ANOVA determined that there were statistically significant differences in participants' use of VLS when gaming [$F(3.66, 420.71) = 21.22$, $p < .001$, $\eta_p^2 = .16$, $1—\beta = 1.00$]. Note that Mauchly's test indicated that the assumption of sphericity had been violated [$\chi^2(9) = .75$, $p < 001$] and so the degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .91$). Post hoc analysis with a Bonferroni adjustment revealed that participants preferred inferencing statistically significantly more than rehearsal [1.01, 95% CI (.57, 1.44), $p < .001$], visualization [.78, 95% CI (.34, 1.22), $p < .001$], use of language references [.92, 95% CI (.48, 1.37), $p < .001$], and notetaking [1.24, 95% CI (.84, 1.64), $p < .001$]. The results also showed that visualization was statistically significantly favoured by participants over notetaking [.46, 95% CI (.05, .87), $p = .017$].

Multivariate regression was subsequently conducted to ascertain the extent to which participants' use of VLS when gaming predicted their English vocabulary knowledge, both receptive (V_YesNo v1.0) and productive (Lex30). Their engagement in EE activities besides gaming (based on whether they engaged passively or produced language during the activities), gaming frequency per game genre, and gender were included as covariates in the regression. The results indicated that the model was a good fit for the data with the receptive [$R_{adj}^2 = .27$, $F(19,94) = 3.16$, $p < .001$, $\eta_p^2 = .39$, $1–\beta = 1.00$; Durban–Watson = 1.81; Min. Std. Residual = −2.32; Max. Std. Residual = 2.10] and productive [$R_{adj}^2 = .18$, $F(19,94) = 2.31$, $p = .004$, $\eta_p^2 = .32$, $1–\beta = .99$; Durban–Watson = 1.97; Min. Std. Residual = −1.86; Max. Std. Residual = 1.66] vocabulary test scores as the outcome variables, though the variances explained by the model were relatively modest.

Parameter estimates (see Table 4) indicated that inferencing when gaming was the most consistently statistically significant (and positive) predictor of receptive and productive vocabulary knowledge, whereas notetaking only statistically significantly (and positively) predicted productive vocabulary knowledge. The regression analysis also revealed that using language references as a strategy when gaming was marginally statistically significant and correlated negatively with productive vocabulary

Table 4. Regression parameter estimates.

Outcome variable	Predictors		*B*	*t*	*p*	95% CI LB	95% CI UB	η_p^2	$1-\beta$
Productive vocabulary test		Intercept	53.40	2.28	.025	6.92	99.88	.05	.62
		Gender	−.54	−.08	.938	−14.26	13.18	.00	.05
	EE activities besides gaming	Passive EE	7.32	.96	.342	−7.90	22.55	.01	.16
		Productive EE	−8.88	−1.20	.232	−23.52	5.76	.02	.22
	Vocabulary learning strategies	Rehearsal	−6.13	−1.72	.088	−13.18	.93	.03	.40
		Visualisation	4.85	1.61	.111	−1.14	10.84	.03	.36
		Inferencing	5.94	2.21	.030	.60	11.28	.05	.59
		References	−4.67	−1.99	.050	−9.35	.00	.04	.50
		Notetaking	5.90	2.08	.040	.28	11.53	.04	.54
	Gaming frequency per game genre	RPG	−4.96	−.84	.402	−16.67	6.74	.01	.13
		Sport	−3.20	−1.10	.273	−8.95	2.56	.01	.19
		Strategy	1.03	.24	.810	−7.40	9.45	.00	.06
		Adventure	−1.66	−.41	.681	−9.64	6.33	.00	.07
		Driving	−4.92	−1.29	.202	−12.52	2.68	.02	.25
		Shooters	3.10	.99	.323	−3.10	9.30	.01	.17
		Party	9.34	1.41	.163	−3.86	22.54	.02	.29
		Sandbox	3.69	.90	.372	−4.47	11.84	.01	.14
		Platformer	−7.24	−1.26	.209	−18.60	4.13	.02	.24
		MOBA	5.44	.60	.551	−12.62	23.49	.00	.09
		Puzzle	−8.78	−1.43	.157	−20.99	3.43	.02	.29
Receptive vocabulary test		Intercept	4225.56	3.44	.001	1784.01	6667.11	.11	.93
		Gender	−448.11	−1.23	.220	−1168.79	272.57	.02	.23
	EE activities besides gaming	Passive EE	191.15	.47	.636	−608.55	990.85	.00	.08
		Productive EE	−620.39	−1.60	.113	−1389.62	148.84	.03	.35
	Vocabulary learning strategies	Rehearsal	124.61	.67	.506	−246.18	495.40	.00	.10
		Visualisation	−243.43	−1.54	.128	−558.03	71.17	.02	.33
		Inferencing	518.72	3.67	.000	238.22	799.23	.13	.95
		References	−186.47	−1.51	.135	−431.86	58.93	.02	.32
		Notetaking	−24.72	−.17	.868	−320.06	270.62	.00	.05
	Gaming frequency per game genre	RPG	34.34	.11	.912	−580.48	649.16	.00	.05
		Sport	92.89	.61	.543	−209.49	395.27	.00	.09
		Strategy	326.52	1.47	.146	−115.94	768.97	.02	.31
		Adventure	289.11	1.37	.174	−130.15	708.37	.02	.27
		Driving	−545.85	−2.71	.008	−945.19	−146.51	.07	.77
		Shooters	−173.52	−1.06	.293	−499.26	152.22	.01	.18
		Party	−557.82	−1.60	.114	−1251.29	135.64	.03	.35
		Sandbox	139.77	.65	.519	−288.64	568.17	.00	.10
		Platformer	−12.95	−.04	.966	−610.11	584.21	.00	.05
		MOBA	714.75	1.50	.138	−233.65	1663.16	.02	.32
		Puzzle	139.04	.43	.668	−502.25	780.33	.00	.07

Note. MOBA: multiplayer online battle arena; RPG: role-playing game.

knowledge, whereas playing driving games correlated negatively with receptive vocabulary knowledge.

5. Discussion

This study investigated the use of VLS by EFL learners from a Norwegian secondary school during extramural gaming and its correlation, alongside gaming frequency and engagement in other EE activities, with their vocabulary knowledge. The findings provide new insights into the relationship between VLS use during gaming and vocabulary learning outcomes, particularly in the Scandinavian context where students commence

learning English in the first grade. They are also interesting in that they show that extramural gaming frequency did not generally correlate significantly with receptive or productive vocabulary knowledge (except in the case of driving games; see Table 4), which is in contrast to other EE studies, such as the one by Puimège and Peters (2019, p. 969), where gaming and video streaming frequency correlated positively with word knowledge and "seemed to play a more consistent role" than passive EE exposure and reading "in predicting participants' word knowledge".

Regarding the first research question, the findings indicated that participants preferred inferencing most when gaming, followed by visualization. In contrast, they used notetaking the least. This preference for inferencing could be attributed to the immersive nature of gaming environments (Pasfield-Neofitou, 2014), where players are often exposed to various in-game contexts, dialogue, and scenarios that can reinforce learning new vocabulary. Such immersion may also prompt gamers to avoid disruptions as much as possible, likely explaining the unpopularity of notetaking among our participants. These claims are borne out in the study by Chen and Yang (2013) involving 22 college students in Taiwan playing an adventure game. The researchers discovered that notetaking frequency *decreased* as participants progressed in the game, which they attributed to notetaking being "interruptive" and possibly spoiling the "fun of gaming" (p. 138). Additionally, gamers often rely on visual and interactive cues within the game itself, as part of their immersion, reducing the desire for external notetaking. Indeed, our participants may have used visualization strategies alongside inferencing because gamers tend to create mental images related to the game's content, aiding in word recall, something that finds support in Ng et al.'s (2022) ethnographic study of four adult gamers (23–24 years old). Ng et al. discovered that their participants relied primarily on cognitive strategies, of which inferencing is a part, followed by memory strategies, which include visualization (see also Ng & Raghbir, 2021). Bytheway (2014), likewise, reported that her participants' VLS when gaming primarily comprised visualization techniques, relying on context, and the use of language references.

As for the second research question, the data revealed that participants' use of VLS when gaming had a wider predictive effect (i.e. a greater number of strategies were predictive) on their productive vocabulary knowledge than receptive vocabulary knowledge. Specifically, participants' productive vocabulary knowledge was positively predicted by inferencing and notetaking. It was also negatively and marginally (in terms of statistical significance; see Table 4) correlated with the use of language references. In contrast, their receptive vocabulary knowledge was only statistically significantly and positively predicted by inferencing. The correlations between the use of inferencing strategies when gaming

and better vocabulary learning outcomes, as measured by the two tests in our study, are not unexpected seeing as similar outcomes were observed by Smith et al. (2013), who found that games that promoted vocabulary learning through inferencing led to better vocabulary acquisition "than standard rote-memorization vocabulary practices that use hardcopy lists of new vocabulary words and multiple-choice questions" (p. 283). Smith et al. felt that the effects of inferencing on vocabulary learning were consistent with the levels of processing model (Craik & Lockhart, 1972) in that "the elaborative process required for making inferences results in deeper, more effective encoding" (p. 283). Notetaking, meanwhile, much like in the study by Chen and Yang (2013), did not statistically significantly correlate with receptive vocabulary scores, though it did positively predict productive vocabulary knowledge.

The differences observed in notetaking's predictive ability could be due to variations in the cognitive processes governing receptive and productive vocabulary knowledge (Teichroew, 1982). Specifically, notetaking represents productive engagement involving the processing and encoding of information, as well as its storage on an external device (or product) for review in the future (Di Vesta & Gray, 1972). Such engagement can enhance one's ability to recall and use words because productive vocabulary knowledge entails, as Teichroew (1982) notes, the ability to *fully* specify words, whereas, regarding receptive knowledge, it is not "necessary or even useful for a whole word to be present 'physically' for it to be recognized; the presence of some information will make it recognizable" (p. 13). As such, while notetaking positively correlated with participants' productive vocabulary knowledge, it had no significant links with their receptive vocabulary knowledge because participants were likely already able to *recognize* the words they encountered when gaming (despite not always being able to produce them all), making notetaking a superfluous activity in this respect. Concerning the negative correlations observed for language references, the findings were somewhat unexpected since studies on language learning (but not gaming) show a positive correlation between their use and learning outcomes (for a meta-analysis, see Zhang et al., 2021). Some researchers, however, note that language references can be disruptive (Liu & Lin, 2011) or have limited benefits (Fotouhi-Ghazvini et al., 2009) for language learning: Liu and Lin (2011, p. 381) note that 'vocabulary searching may be associated more with extraneous cognitive load and thus may negatively affect reading comprehension' due to 'the constant attention-switching, head-turning, and task-switching between media'. Perhaps using language references when gaming disrupts the flow of gameplay, causing players to lose focus and ultimately hindering their ability to use vocabulary spontaneously in their communication.

Finally, the results of the regression revealed that playing driving games correlated negatively with participants' receptive vocabulary knowledge (see Table 4). Driving games can often contain minimal vocabulary because they primarily focus on the simulation of driving vehicles, with the main emphasis being on the player's ability to navigate obstacles and routes and control a vehicle within the game environment rather than engaging in extensive verbal or written communication. This results in a reduced imperative to learn vocabulary compared to other game genres that may have more narrative-driven or communicative elements. This can be seen, to some extent, in the study by Tang (2023), where the use of driving games to support word learning (English) among preschoolers in Taiwan had no significant effect on their vocabulary acquisition.

6. Conclusion

Students' extramural experiences in a foreign language can have significant implications for both teachers and educational institutions. For teachers interested in integrating gaming into foreign language instruction to boost their students' learning, the findings from our study suggest that rather than focusing on gaming frequency, they may achieve better vocabulary learning outcomes by prioritizing the development of learners' abilities in inferencing and notetaking during these activities. This can be implemented in the classroom through discussions with students about the effectiveness of specific VLS and by suggesting game-integrated tasks as homework that target these skills (for those students who play games extramurally, see Chen & Yang, 2013). It is important to emphasize here that differences exist between formal learning and extramural contexts that extend beyond their linguistic and content-related elements; however, these differences do not undermine the argument that teachers can leverage students' EE experiences to enhance their learning. For researchers, the findings underscore the importance of considering the relationship between learners' use of VLS while engaged in EE and their receptive and productive vocabulary knowledge, as they can and do report independently using such strategies, at least when gaming. This implies a shift away from solely focusing on EE activity types and activity frequency, a norm in EE research, to paying more attention to learner behaviour during EE, especially in relation to how they process language in extramural encounters.

At the same time, it is important to acknowledge that our study is not without its limitations. The findings are derived from participants in a single school, and the limited sample size may affect the robustness of the statistical measures used, impacting the generalizability of the findings and warranting caution in extrapolating the results to

broader populations. Additionally, the study relied on self-reports to collect data on participants' VLS, gaming frequency, and engagement in other EE activities, meaning that the data may not reflect participants' actual, observable behaviour. Another concern is that the VLS scale used in the study may not have captured all the VLS that participants employed when gaming. Collecting additional data via interviews would have strengthened the import of the findings, though logistics made such an undertaking difficult. Despite these limitations, the findings revealed participants' preferences for certain VLS and a consistent correlation between their vocabulary knowledge and one set of VLS. As one moves forward, future studies could address some of the limitations enumerated above and build on the study's findings. For example, in terms of research methods, apart from self-reports, as utilized in our study, future research projects could explore the possibility of using stimulated recall or even eye-tracking technology to capture moment-to-moment language processing and strategy use during EE activities, including gaming.

Studies could also investigate the relationship between gaming extramurally and the use of learning strategies to develop other aspects of English proficiency, such as grammar knowledge or literacy skills (instead of focusing purely on vocabulary knowledge, as was done in our study), as well as explore how *multimodal* competence mediates the relationship between VLS use during EE activities (e.g. gaming) and vocabulary learning outcomes. Multimodal competence, which encompasses the ability to comprehend and use various communication modes, including written and spoken language, images, and gestures, was not evaluated in our study (visualisation strategies notwithstanding), yet it may play a pivotal role in how learners process and learn language when gaming. For instance, players often rely on a combination of verbal communication, visual cues from the game environment, and even non-verbal expressions like emoticons or gestures to interact with others and the in-game world. Currently, there is a dearth of measures that fully encompass the multimodal nature of interactions within the gaming environment, even if they can include a visual encoding component (see Gu, 2018). This presents researchers with the opportunity to develop and test new measures that more accurately capture the multimodal nature of gamer behaviour in relation to language learning during gaming.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice Hall.

Brevik, L. M. (2016). The gaming outliers: Does out-of-school gaming improve boys' reading skills in English as a second language?. In *Educational technology and polycontextual bridging* (pp. 39–61) Brill.

Bytheway, J. (2014). In-game culture affects learners' use of vocabulary learning strategies in massively multiplayer online role-playing games. *International Journal of Computer-Assisted Language Learning and Teaching*, *4*(4), 1–13. https://doi.org/10.4018/ijcallt.2014100101

Bytheway, J. (2015). A taxonomy of vocabulary learning strategies used in massively multiplayer online role-playing games. *Calico Journal*, *32*(3), 508–527. https://doi.org/10.1558/cj.v32i3.26787

Calafato, R., & Gudim, F. (2022). Comics as a multimodal resource and students' willingness to communicate in Russian. *Journal of Graphic Novels and Comics*, *13*(2), 270–286. https://doi.org/10.1080/21504857.2021.1951788

Calafato, R. (2023). Charting the motivation, self-efficacy beliefs, language learning strategies, and achievement of multilingual university students learning Arabic as a foreign language. *Asian-Pacific Journal of Second and Foreign Language Education*, *8*(1), 20. https://doi.org/10.1186/s40862-023-00194-5

Chen, H. J., & Yang, T. Y. (2013). The impact of adventure video games on foreign language learning and the perceptions of learners. *Interactive Learning Environments*, *21*(2), 129–141. https://doi.org/10.1080/10494820.2012.705851

Cohen, J. (1969). *Statistical power analysis for the behavioural sciences*. Academic Press.

Craik, F. I., & Lockhart, R. S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior*, *11*(6), 671–684. https://doi.org/10.1016/S0022-5371(72)80001-X

De Wilde, V., Brysbaert, M., & Eyckmans, J. (2020). Learning English through out-of-school exposure: Which levels of language proficiency are attained and which types of input are important? *Bilingualism: Language and Cognition*, *23*(1), 171–185. https://doi.org/10.1017/S1366728918001062

Di Vesta, F. J., & Gray, G. S. (1972). Listening and note taking. *Journal of Educational Psychology*, *63*(1), 8–14. https://doi.org/10.1037/h0032243

Dörnyei, Z., & Ryan, S. (2015). *The psychology of the language learner revisited*. Routledge.

Dörnyei, Z., & Skehan, P. (2003). Individual differences in second language learning. In C. J. Doughty, & M. H. Long (Eds.), *The handbook of second language acquisition* (pp. 589–630). Blackwell.

Fotouhi-Ghazvini, F., Earnshaw, R., Robison, D., & Excell, P. (2009). The MOBO City: A mobile game package for technical language learning. *International Journal of Interactive Mobile Technologies (iJIM)*, *3*(2), 19–24. https://doi.org/10.3991/ijim.v3i2.757

Griffiths, C. (2020). Language learning strategies: Is the baby still in the bathwater? *Applied Linguistics*, *41*(4), 607–611. https://doi.org/10.1093/applin/amy024

Gu, P. Y. (2018). Validation of an online questionnaire of vocabulary learning strategies for ESL learners. *Studies in Second Language Learning and Teaching*, *8*(2), 325–350. https://doi.org/10.14746/ssllt.2018.8.2.7

Heidt, J., Pinchbeck, G., & Rodgers, M. P. (2023). The good gaming (GG) list: Key vocabulary in video games. In *Vocabulary learning in the wild* (pp. 143–161) Springer.

Ibrahim, K. (2022). Understanding L2 use in MMOGs: A linguistic framework of digital gaming. *Foreign Language Annals*, *55*(4), 1169–1187. https://doi.org/10.1111/flan.12659

Jabbari, N., & Eslami, Z. R. (2019). Second language learning in the context of massively multiplayer online games: A scoping review. *ReCALL*, *31*(1), 92–113. https://doi.org/10.1017/S0958344018000058

Jensen, S. H. (2017). Gaming as an English language learning resource among young children in Denmark. *Calico Journal*, *34*(1), 1–19. https://doi.org/10.1558/cj.29519

Lee, J. S., & Lu, Y. (2023). L2 motivational self system and willingness to communicate in the classroom and extramural digital contexts. *Computer Assisted Language Learning*, *36*(1-2), 126–148. https://doi.org/10.1080/09588221.2021.1901746

Leona, N. L., van Koert, M. J., van der Molen, M. W., Rispens, J. E., Tijms, J., & Snellings, P. (2021). Explaining individual differences in young English language learners' vocabulary knowledge: The role of Extramural English Exposure and motivation. *System*, *96*, 102402. https://doi.org/10.1016/j.system.2020.102402

Liu, T. C., & Lin, P. H. (2011). What comes with technological convenience? Exploring the behaviours and performances of learning with computer-mediated dictionaries. *Computers in Human Behavior*, *27*(1), 373–383. https://doi.org/10.1016/j.chb.2010.08.016

Long, M. H. (1981). Input, interaction, and second language acquisition. *Annals of the New York Academy of Sciences*, *379*, 259–278. https://doi.org/10.1111/j.1749-6632.1981.tb42014.x

Meara, P., & Fitzpatrick, T. (2000). Lex30: An improved method of assessing productive vocabulary in an L2. *System*, *28*(1), 19–30. https://doi.org/10.1016/S0346-251X(99)00058-5

Meara, P., & Miralpeix, I. (2016). *Tools for researching vocabulary*. Multilingual Matters.

Nardi, B., Ly, S., & Harris, J. (2007). Learning conversations in World of Warcraft. *Proceedings of the 2007 Hawaii International Conference on Systems Science* (pp. 1–10) IEEE Press.

Ng, L. L., & Raghbir, R. S. (2021). Learning English vocabulary via computer gaming. *Issues in Language Studies*, *10*(1), 93–109.

Ng, L. L., Azizie, R. S., & Chew, S. Y. (2022). Factors influencing ESL players' use of vocabulary learning strategies in massively multiplayer online role-playing games (MMORPG). *The Asia-Pacific Education Researcher*, *31*(4), 369–381. https://doi.org/10.1007/s40299-021-00578-6

Norouzian, R., & Plonsky, L. (2018). Eta-and partial eta-squared in L2 research: A cautionary review and guide to more appropriate usage. *Second Language Research*, *34*(2), 257–271. https://doi.org/10.1177/0267658316684904

Oxford, R. L. (2017). *Teaching and researching language learning strategies: Self-regulation in context*. Routledge.

Pasfield-Neofitou, S. (2014). Language learning and socialization opportunities in game worlds: Trends in first and second language research. *Language and Linguistics Compass*, *8*(7), 271–284. https://doi.org/10.1111/lnc3.12083

Pawlak, M. (2021). Investigating language learning strategies: Prospects, pitfalls and challenges. *Language Teaching Research*, *25*(5), 817–835. https://doi.org/10.1177/1362168819876156

Plonsky, L., & Oswald, F. L. (2014). How big is "big"? Interpreting effect sizes in L2 research. *Language Learning*, *64*(4), 878–912. https://doi.org/10.1111/lang.12079

Preacher, K. J., Zhang, G., Kim, C., & Mels, G. (2013). Choosing the optimal number of factors in exploratory factor analysis: A model selection perspective. *Multivariate Behavioral Research*, *48*(1), 28–56. https://doi.org/10.1080/00273171.2012.710386

Puimège, E., & Peters, E. (2019). Learners' English vocabulary knowledge prior to formal instruction: The role of learner-related and word-related variables. *Language Learning*, *69*(4), 943–977. https://doi.org/10.1111/lang.12364

Rama, P. S., Black, R. W., Van Es, E., & Warschauer, M. (2012). Affordances for second language learning in World of Warcraft. *ReCALL*, *24*(3), 322–338. https://doi.org/10.1017/S0958344012000171

Reinhardt, J. (2018). *Gameful second and foreign language teaching and learning: Theory, research, and practice*. Springer.

Reinhardt, J., & Han, Y. (2021). Learnful L2 gaming: The wisdom of the wild. In C. Fuchs, M. Hauck, & M. Dooly (Eds.), *Language education in digital spaces: Perspectives on autonomy and interaction*. Springer.

Rød, A. J., & Calafato, R. (2024). Exploring extramural English: Impacts, integration and future directions. In A. S. Skulstad (Ed.), *Current issues in English teaching* (pp. 117–140). Fagbokforlaget.

Rød, A. J., & Calafato, R. (2023). Exploring the relationship between extramural English, self-efficacy, gender, and learning outcomes: A mixed-methods study in a Norwegian upper-secondary school. *Studies in Educational Evaluation*, *79*, 101302. https://doi.org/10.1016/j.stueduc.2023.101302

Ryu, D. (2013). Play to learn, learn to play: Language learning through gaming culture. *ReCALL*, *25*(2), 286–301. https://doi.org/10.1017/S0958344013000050

Smith, G. G., Li, M., Drobisz, J., Park, H. R., Kim, D., & Smith, S. D. (2013). Play games or study? Computer games in eBooks to learn English vocabulary. *Computers & Education*, *69*, 274–286. https://doi.org/10.1016/j.compedu.2013.07.015

Sundqvist, P., & Sylvén, L. K. (2016). *Extramural English in teaching and learning: From theory and research to practice*. Springer.

Sundqvist, P., & Wikström, P. (2015). Out-of-school digital gameplay and in-school L2 English vocabulary outcomes. *System*, *51*, 65–76. https://doi.org/10.1016/j.system.2015.04.001

Swain, M. (2006). Languaging, agency and collaboration in advanced second language learning. In H. Byrnes (Ed.), *Advanced language learning: The contributions of Halliday and Vygotsky* (pp. 95–108). Continuum.

Tang, J. T. (2023). Comparative study of game-based learning on preschoolers' English vocabulary acquisition in Taiwan. *Interactive Learning Environments*, *31*(4), 1958–1973. https://doi.org/10.1080/10494820.2020.1865406

Teichroew, F. J. (1982). Receptive versus productive vocabulary : A survey. *Interlanguage Studies Bulletin*, *6*(2), 5–33.

Thorne, S. L. (2008). Transcultural communication in open Internet environments and massively multiplayer online games. In S. Magnan (Ed.), *Mediating Discourse Online* (pp. 305–327). John Benjamins.

Uztosun, M. S., & Kök, M. (2023). L2 skill-specific anxiety and communication apprehension: The role of extramural English in the Turkish context. *Innovation in Language Learning and Teaching*, *18*(1), 17–31. https://doi.org/10.1080/17501229.2023.2217170

Vazquez-Calvo, B. (2018). The online ecology of literacy and language practices of a gamer. *Journal of Educational Technology & Society*, *21*(3), 199–212.

Walters, J. (2012). Aspects of validity of a test of productive vocabulary: Lex30. *Language Assessment Quarterly*, *9*(2), 172–185. https://doi.org/10.1080/15434303.2011.625579

Warnby, M. (2022). Receptive academic vocabulary knowledge and extramural English involvement–is there a correlation? *ITL-International Journal of Applied Linguistics*, *173*(1), 120–152. https://doi.org/10.1075/itl.21021.war

Xu, Z., Chen, Z., Eutsler, L., Geng, Z., & Kogut, A. (2020). A scoping review of digital game-based technology on English language learning. *Educational Technology Research and Development*, *68*, 877–904. https://doi.org/10.1007/s11423-019-09702-2

Yu, Z., Xu, W., & Sukjairungwattana, P. (2023). Motivation, learning strategies, and outcomes in mobile English language learning. *The Asia-Pacific Education Researcher*, *32*(4), 545–560. https://doi.org/10.1007/s40299-022-00675-0

Zhang, R., Zou, D., Cheng, G., Xie, H., Wang, F. L., & Au, O. T. (2021). Target languages, types of activities, engagement, and effectiveness of extramural language learning. *PLoS One*. *16*(6), e0253431. https://doi.org/10.1371/journal.pone.0253431

Zhang, S., Xu, H., & Zhang, X. (2021). The effects of dictionary use on second language vocabulary acquisition: A meta-analysis. *International Journal of Lexicography*, *34*(1), 1–38. https://doi.org/10.1093/ijl/ecaa010