

The use of online writing tools by learners of English: Evidence from a process corpus

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Abstract

This paper examines the use of online writing tools by French-speaking learners of English based on the analysis of screen recordings of a free composition task that come from the Process Corpus of English in Education, a process corpus of learner writing. The study charts learners' use of online resources by investigating how often learners resort to tools, which tools they use, and what effect the use of tools has on their texts. Results show considerable individual variation in the extent to which learners use online tools and a general propensity to rely on a limited range of tool types, most often bilingual tools. Overall, the use of tools helps learners improve their texts, but a close examination of their consultation behaviour also reveals shortcomings in learners' strategies, such as a tendency to carry out single-word searches or a lack of critical thinking about the information that tools provide.

Keywords: dictionary use, corpus use, online resources, search strategies, EFL writing, learner corpus, writing process, screencasting

1. Introduction

The advent of the Internet has given people access to a wealth of information, among which many useful tools to improve one's use of language – especially English – for example dictionaries, corpus interfaces, automatic translators, or language forums. The effect of these online writing tools on writers' production, and in particular on the production of learners who write in a foreign language, has been widely studied over the last few years. In this study, we approach the question on the basis of a new type of resource, namely a process learner corpus, that is, a learner corpus which represents the process leading to a finished written product (see Gilquin 2021). More particularly, we rely on the screencast videos of the Process Corpus of English in Education, which we analyze with the techniques of corpus linguistics, annotating the videos and then extracting information about learners' use of online writing tools and their effects on the text being written. The corpus linguistic approach allows us to combine quality and quantity, resulting in the precise and systematic analysis of a large sample of data, corresponding to the free compositions of 84 higher-intermediate to advanced French-speaking learners of English writing for about 45 minutes each. Different aspects of their use of online writing tools are investigated, with the aim of providing a detailed description of their consultation behaviour, including both efficient and less efficient strategies, and testing hypotheses derived from investigations of smaller and/or more constrained data samples, which are more common in the literature.

The article first presents a review of the research conducted on the use of writing tools by learners, with a special focus on the methods adopted by these studies. In Section 3, we describe the design of the study, including the research questions, the participants, the data, and their annotation. Section 4 outlines the main findings of the analysis. It is structured around our three research questions, namely: how much do learners use online writing tools? (Section 4.1), what online writing tools do learners use? (Section 4.2), and are online writing tools helpful? (Section 4.3). These findings are discussed in Section 5, before some concluding remarks in Section 6.

2. Researching the use of writing tools by learners

2.1. *Types of writing tools investigated*

The importance of writing tools for language learners has led many scholars to investigate their use by learners and their effects on learners' writing. While earlier studies examined the use of printed dictionaries (e.g. Béjoint 1981), the availability of computer-based resources has shifted the focus to electronic dictionaries but also corpus interfaces. Dictionaries and corpora are usually considered separately. Studies that deal with dictionaries often adopt a comparative approach, comparing the use of a dictionary with no dictionary use (Lew 2016), comparing paper and electronic dictionaries (Dziemianko 2010), or comparing monolingual and bilingual dictionaries (Ng 2016), for instance. They also examine learners' use of certain parts of dictionary entries (e.g. grammatical information and examples in Chan 2012, definitions and pictorial illustrations in Lew et al. 2018) or the effect of dictionary use on learners' production and retention of certain linguistic phenomena (e.g. Laufer 2011 on collocations, Liang and Xu 2017 on the middle construction). Most of the time, these studies involve learners having to use a specific dictionary (Lew 2016, Chen 2017) or set of dictionaries (Nurmukhamedov 2017), or even a specific set of dictionary entries (Laufer 2011) or edited dictionary entries (Chan 2012).

The use of corpora as a writing tool is mostly described in the literature on data-driven learning (DDL; see Gilquin and Granger forthcoming). Typically, empirical studies in DDL involve giving learners access to corpus data, either directly (in the form of a corpus which they can search themselves) or indirectly (in the form of materials prepared by the teacher on the basis of a corpus). Three aspects can then be evaluated (Boulton 2008: 41): learners' attitudes towards DDL, their practices (what they do and how well they do it), and the efficiency of DDL for these learners, which can be determined by comparing them with a control group of learners taught the same topic with a more traditional method. As is the case with studies on the use of dictionaries, learners are normally asked to work with a specific corpus (Yoon 2008, Mueller and Jacobsen 2015) or set of corpora (Gilmore 2009, Liu and Jiang 2009).

Studies that integrate dictionaries and corpora are comparatively quite rare. Boulton (2009) compares learners' use of corpus data with their use of traditional resources (bilingual dictionary and grammar/usage manual). Corpora appear to be more effective than traditional resources for reference purposes, but no differences are found in terms of recall of the information. Landure (2013) investigates learners' use of a bilingual dictionary, a monolingual dictionary, and a generic corpus. She shows that corpus consultation requires more time than dictionary consultation, and that each type of tool tends to be more efficient for certain aspects: bilingual corpora for translation, monolingual dictionaries and corpora for the form of the items, and corpora for the co-text. In Mueller and Jacobsen (2015), the use of an online corpus proves to be difficult for learners, but enables them to perform marginally better on a revision task than the use of an electronic dictionary. In all these three studies, the choice of tools is made by the researchers (with the exception of the dictionary in Mueller and Jacobsen 2015, which is the participants' own choice). This is also the case in Yoon (2016a, 2016b), although in that study participants have access to an interface combining as many as eight different resources: four online dictionaries (a monolingual dictionary, a bilingual dictionary, a collocation dictionary, and a thesaurus), three Google search engines (Google Web, Google Scholar, and Custom Search Engine), and the Corpus of Contemporary American English (COCA). The learners are free to use these resources as they wish during a writing assignment. In a small number of studies, participants are free to use whatever resources they want, for example in Kennedy and Miceli (2010), Pérez-Paredes et al. (2011), or Müller-Spitzer et al. (2018).

2.2. *Methods adopted*

Two main methods have been used to investigate learners' use of writing tools: asking learners to evaluate their own use of the writing tools and asking learners to complete a writing task so as to assess the efficiency of their consultation behaviour. The first method can be illustrated by Yoon and Hirvela's (2004) study, in which learners receive training and practice in corpus consultation and are then required to fill in a questionnaire and, for some of them, to participate in a semi-structured interview. The aim of the questionnaire/interview is to probe into learners' use of the Collins COBUILD Corpus, by asking them, for example, how helpful they consider corpus use to be, whether they find it more helpful than a dictionary, or whether they think that using the corpus has improved their writing skills. Examples of studies with a similar method include Taylor and Chan (1994) and Hadley (2002). This type of approach is very indirect and subjective, as it relies solely on learners' perceptions of their use of writing tools. The second method is also indirect, but more objective, as it takes account of learners' actual results on certain tasks. In Li (2017), for example, learners have to write essays before and after receiving training in corpus consultation. Their use of collocations is compared before and after the training, as well as with the use of collocations by a control group with no access to a corpus. Other studies that adopt this type of approach include Gilmore (2009), Lew (2016), and Liang and Xu (2017). Most of the studies that have investigated the use of writing tools by learners employ one of these two indirect methods. This is the case, for example, of a large majority of the bibliographical references included in Nesi's (2014) literature review of studies on the use of dictionaries by learners of English.

As rightly underlined by Pérez-Paredes et al. (2011: 234), besides focusing 'on learners' opinions and learning outcomes', it is important to 'give an account of students' interaction with the resources'. The aim, in such an approach, is to observe the consultation behaviour as it unfolds or, as Hatherall (1984: 184) puts it, to 'watch users in action'. This is what Kim (2018) and Bridle (2019) seek to do: the former asks learners to vocalize their thoughts and interactions with an online dictionary ('think-aloud protocol') while performing a collocation revision task, whereas the latter asks learners to revise their essays and note the correction method for each revision (own knowledge, corpus, dictionary, other). Technology, however, makes it possible to provide a more accurate and reliable picture of learners' real-time interactions with computer-based resources, while also using less obtrusive and disrupting methods. Pérez-Paredes et al. (2011) thus rely on tracking techniques to generate logs that show exactly how learners use the British National Corpus (BNC) (e.g. number of searches, number of words per search). Chen (2017) applies these techniques to record and investigate learners' interactions with a dictionary when they have to complete a collocation task. Some scholars use video-screen capture technology for the same purpose. Kennedy and Miceli (2010), for example, record learners' computer screen activity while they are carrying out a writing task. The videos are available during semi-structured interviews with the learners aimed at retrospectively eliciting information about their use of reference tools 'to prompt the memory where necessary' (Kennedy and Miceli 2010: 35). Yoon (2016a) adopts a similar approach of 'stimulated recall' to find out about learners' 'intentions behind each query and decision they made' (Yoon 2016a: 216). Screencast videos may be even more central to the analysis. Hamel (2012) tests an online dictionary prototype for learners of French by recording their screen activity during several language learning tasks. While her ultimate aim is to improve the dictionary, she also makes interesting findings about learners' use of the dictionary. Bailey and Withers (2018) rely on video-screen capture to examine learners' use of software tools during a paraphrasing task. They code the videos according to learners' actions (e.g. 'typing', 'revising', 'use of synonym finder', 'use of thesaurus tool') and can thus show what learners' preferred tools are. As for Müller-Spitzer et al. (2018), they

combine video-screen capture and think-aloud protocols to examine what learners actually do and think while carrying out a correction task with free access to online language resources. Lew et al. (2018) illustrate yet another technique to observe learners' interactions with writing tools, namely eye-tracking, which allows them to investigate learners' gaze patterns during dictionary consultation, with special focus on the division of attention between verbal and pictorial elements in a dictionary entry. Tono (2011) uses the same technique to examine learners' look-up processes within the microstructure of dictionary entries. By observing the learner's actual interactions with the writing tools as they happen, the studies described in this paragraph go beyond earlier studies focusing on the product (text/test) and seek to integrate the process dimension. Such studies are however less numerous than product-oriented ones, and the number of participants that they involve tends to be quite limited (e.g. four in Kim 2018, six in Hamel 2012, eight in Lew et al. 2018). Most of them also rely on controlled writing tasks (e.g. paraphrasing a short text in Bailey and Withers 2018 or correcting a set of sentences in Müller-Spitzer et al. 2018) rather than free compositions.

Finally, it should be underlined that some studies rely on multiple sources of information to examine learners' consultation behaviour, sometimes involving the observation of both the product and the process. Hegelheimer (2007), for example, combines questionnaires and interviews with tracking techniques and an analysis of learners' written products. Yoon (2008) uses as many as six different sources: '1) classroom observational notes, 2) interviews, 3) recall protocols, 4) corpus search logs, 5) class corpus search assignments, and 6) written reflections on corpus use' (Yoon 2008: 34).

3. The study

The above literature review shows that, while many studies have investigated the use of online resources by learners, most are to some degree constrained in terms of the task asked of learners and/or the resource(s) they are prompted or allowed to use. The observed consultation behaviours in such studies may therefore not be entirely representative of learners' habitual practices when writing. The studies that have relied on free composition tasks during which learners are free to resort to any resources they like according to their own needs have higher ecological validity but they have generally worked with very small samples, making it hard to know to what extent their findings can be generalized.

Against this backdrop, the present study aims to offer a more reliable characterization of learners' consultation behaviour by assessing their use of online writing tools of their own choice in a free composition task, based on a large sample of learners. Their consultation behaviour is observed directly through video-screen capture technology. The study applies the methods of corpus linguistics, by considering the videos as a corpus to query. This approach makes it possible, once the data have been annotated, to analyze them automatically, which results in a more precise and systematic analysis than has been feasible so far. This also means that larger populations of learners can be investigated, which is an improvement on other studies observing learners' interactions with the writing tools in that one can quantify their practices as a population while also accounting for individual variation in a way that has not been done before. In addition to the 'process data' of the screencast videos, we also look at the process-product interface, examining (i) the direct effect of the use of online tools on the learner's writing and (ii) the link between consultation behaviour and overall text quality.

3.1. *Research questions*

Our general aim of assessing how learners use online writing tools can be broken down into three main research questions and their corresponding hypotheses, which are derived from previous literature:

- **RQ1: How much do learners use online writing tools?** This question is operationalized by the time learners spend using tools and the number of searches carried out per learner.
Hypothesis: Following studies like Kennedy and Miceli (2010), we hypothesize that there is considerable variation among learners as to how much they use online writing tools.
- **RQ2: What online writing tools do learners use?** This question is operationalized by the types of tools used by learners, the number of tool types used per learner, and the comparison between single-tool and multiple-tool searches.
Hypothesis: We expect learners to predominantly rely on bilingual tools, as shown in studies like Laufer (2011) or Quinn (2015), and to do so to the exclusion of other tools.
- **RQ3: Are online writing tools helpful?** This question is operationalized by the effect of the use of tools and the correlation between learners' use of tools and the grades they obtained for their written texts.
Hypothesis: In accordance with Müller-Spitzer et al.'s (2018: 302) finding that 'participants who used more dictionary resources were more successful', it is hypothesized that online writing tools help learners write better texts.

3.2. *Participants*

The participants are 84 French-speaking learners of English as a foreign language from two cohorts of students who attended a course in advanced English language skills at a Belgian university. They studied English as a major and the majority of them were in their third year. Their proficiency level can be described as ranging from higher-intermediate to advanced. Throughout their studies, they had gained practical experience in using dictionaries and, to a lesser extent, corpora, but they did not receive specific training in the use of writing tools within the frame of the course before participating in the task.

3.3. *Data*

The data come from the Process Corpus of English in Education (PROCEED; see Gilquin 2022),¹ which is a process learner corpus, that is, a learner corpus that includes data representing the writing process (keystroke log files and screencast videos) in addition to the finished texts. The data were produced during a writing task taking place in a computer lab, which required learners to write an argumentative essay of about 350 words on one of three set topics. They had about 45 minutes to complete the task. The screen activity was recorded by means of OBS (Open Broadcaster Software) Studio, while Inputlog (Leijten and Van Waes 2013) provided the keystroke log files. Launching Inputlog opens a Word document in which learners can write their texts. Importantly for our purposes, automatic spell and grammar check is not available in this Word document (although learners can manually enable or use the spell and grammar check if they decide to). The analysis for the present study is based on the finished texts (in Word) produced by 84 learners and the corresponding screencast videos. These data represent the output of the first writing task performed by all the French-speaking learners of the first two cohorts of students that contributed to PROCEED.

3.4. Annotation

The analysis of the learners' use of online tools relies primarily on the annotation of the screencast videos. The video files were annotated by means of the ELAN software (Wittenburg et al. 2006), which is a highly versatile open source program designed for multi-layer annotations of videos and audio recordings. Use was made of the annotation protocol for the use of online resources developed by Laporte and Gilquin (2018). The annotation scheme itself is made up of eleven tiers, the most relevant of which for the present study are the following:

- Search: identifies each search, defined as the use of one or several tools to answer one question;
- Tool: records the tool(s) that the learner uses for a search;
- Information type: indicates the type of information that the learner is looking for (e.g. spelling, translation, synonym);
- Query: records the learner's query in a tool;
- Effect: describes whether the search leads to a correct or incorrect formulation in the text, or has no effect on the learner's production;
- Result: records what the learner wrote or revised in the text as a result of the search.

The annotation of the data was carried out by the second author. The annotation scheme and dubious cases were discussed with the first author and annotations were double-checked for consistency when necessary so as to ensure the most reliable annotation possible and minimize subjectivity in the annotation process. When the data annotation was complete, the annotations were exported to an Excel spreadsheet to carry out the quantitative analyses reported in the following section.

4. Results

On the basis of the annotated videos sampled from PROCEED, we sought to answer the three research questions set out in Section 3.1. The main results are presented below.

4.1. *How much do learners use online writing tools?*

The first research question, which looks at how much learners use writing tools, is operationalized by the time learners spend using tools (Section 4.1.1) and the number of searches carried out per learner (Section 4.1.2). In order to test our hypothesis that learners will differ in how much they use tools, special attention is paid to individual variation.

4.1.1. *Time spent using online writing tools.* Writing a text on a computer with the help of online writing tools involves alternating between the text and the writing tools. Table 1 shows how much time (in minutes and percentage) learners spend, on average, on the Word document and on the use of online tools; for the latter, a distinction is made between the use of the tools for writing purposes and for other purposes (e.g. looking up information about a topic). The results for percentages are also shown visually in the form of a boxplot in Figure 1, where each data point (i.e. each learner) is represented by a diamond. It appears from these results that the time learners spend using tools for writing purposes amounts to 13% of the total time on average, as against 85% for the time spent on the Word document. The standard deviations and boxplot, however, show that there is a considerable amount of variation between learners, with some of them not resorting to any tools at all and others spending over 25% of their time using tools, which already points to the individuality of learners' consultation behaviour.

Table 1. Average time in minutes and percentage (with standard deviation) spent writing, using online tools for writing purposes, and using online tools for other purposes

Activity	Average time in min. (sd)	Average % (sd)
Writing	38.7' (sd = 5.1)	85.0% (sd = 8.0)
Tools	6.1' (sd = 3.4)	13.1% (sd = 7.1)
Other	0.9' (sd = 1.0)	1.9% (sd = 2.3)
Total	45.6' (sd = 4.9)	100%

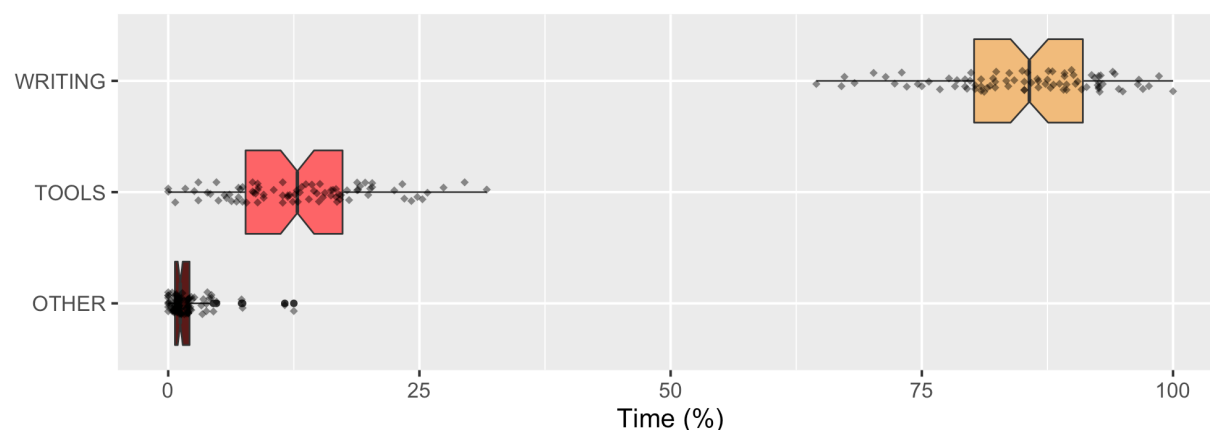


Figure 1. Boxplot of average time (in percentage) spent writing, using online tools for writing purposes, and using online tools for other purposes

4.1.2. *Number of searches per learner.* The individual variation that exists between learners is even more striking when we consider the number of searches carried out per learner (see Table 2 and Figure 2). A search is defined here as each time a learner uses a tool, sometimes several, to answer one specific question. A total of 1,543 searches can be identified in our sample of screencast videos. On average, learners carry out 18.4 searches during the whole writing task, which means an average of one search every two minutes and a half, and they spend an average of 21.4 seconds per search. There is, however, a considerable degree of variation around the mean number of searches, from learners not carrying out a single search to a learner carrying out 49 searches (that is, more than one search per minute). The whole range is to be found between these two extremes, as can be seen from the boxplot in Figure 2, which also highlights two outliers at 48 and 49 searches. Despite the fact that these two learners are outliers in terms of number of searches, it should be noted that this is not the case for the amount of time they spend using tools: a closer inspection of their consultation behaviour reveals a propensity towards many quick searches, with both learners having a mean search length shorter than average.

Table 2. Number of searches carried out per learner

Mean	18.4
sd	10.9
Range	0 - 49

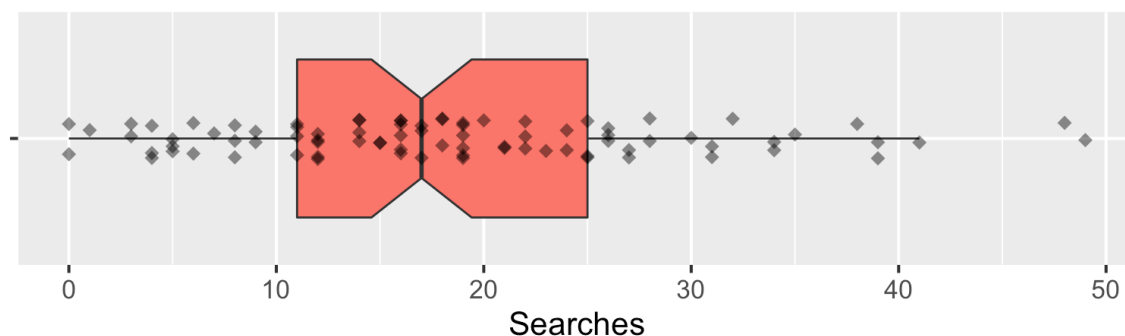


Figure 2. Boxplot of number of searches carried out per learner

4.2. *What online writing tools do learners use?*

With a view to testing the hypothesis that learners will prefer using bilingual tools to the exclusion of others, the second research question examines the writing tools that learners rely on. It is operationalized by the types of tools used by learners (Section 4.2.1), the number of tool types used per learner (Section 4.2.2), and the comparison between single-tool and multiple-tool searches (Section 4.2.3).

4.2.1. *Types of tools.* During the writing task, learners are free to use whatever online tools they want. Figure 3 shows the distribution, with 95% confidence intervals, of the different types of tools that learners rely on for their searches (see Appendix for a list of all the tools used). Bilingual dictionaries are the most often used type of tool (40.6%), followed by bilingual concordancers like Linguee (29.6%). Including online translators, which represent 1.5%, bilingual tools together account for over 70% of all uses of tools by learners, which seems to confirm our hypothesis. The use of monolingual dictionaries accounts for 10.6%, that of thesauri for 7.5%, and that of corpus tools for a small 1.8%. Other tools are occasionally used, among which search engines (4.3%) and language forums (0.4%, included in the ‘Other’ category). As for collocation dictionaries, which are categorized as ‘Other’ too, their use is extremely rare (0.06%), with only one learner resorting to Ozdic once.

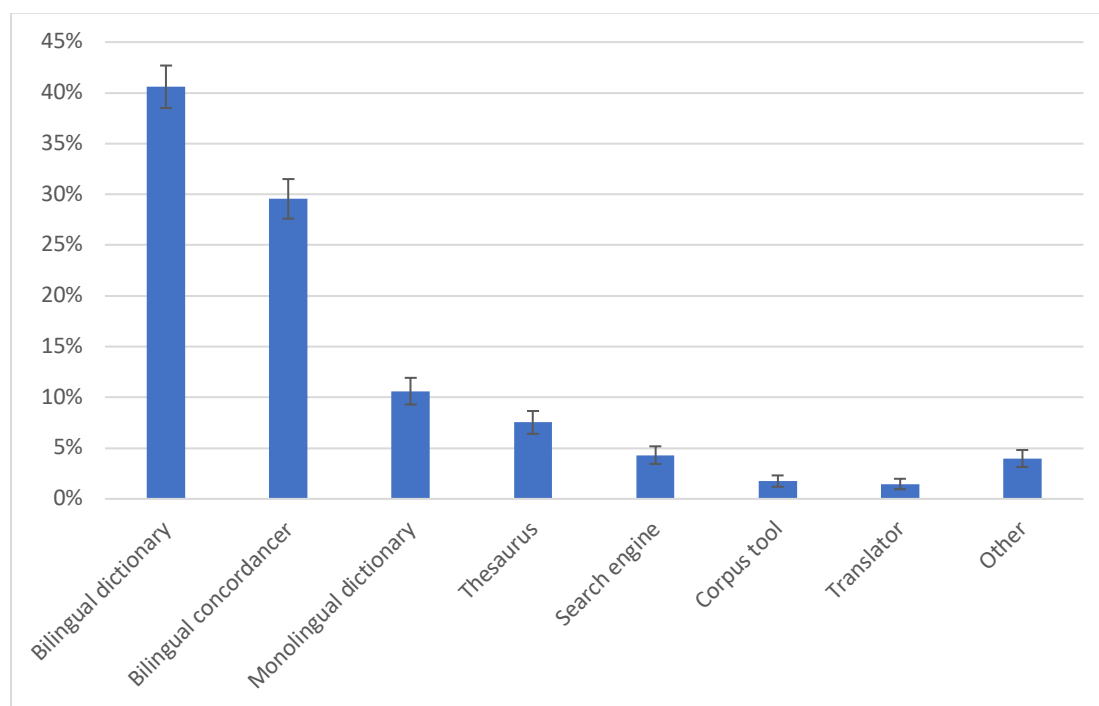


Figure 3. Distribution of the types of tools used by learners with 95% confidence intervals

4.2.2. *Types of tools per learner.* Some learners use a larger variety of tool types than others. As appears from Figure 4, most learners use between one and four different tool types, while there are eight learners who use five, six learners who use six, and only two learners who use seven. Even when learners resort to different tool types, most of the time one of the tool types clearly predominates and, in line with our hypothesis, it is then more often than not bilingual tools that prevail: of learners who use more than one type of tool, 78.3% still rely on bilingual tools for more than half of their searches. This, on the whole, highlights learners' tendency to rely on a limited range of tool types when they write, with a strong preference for bilingual tools.

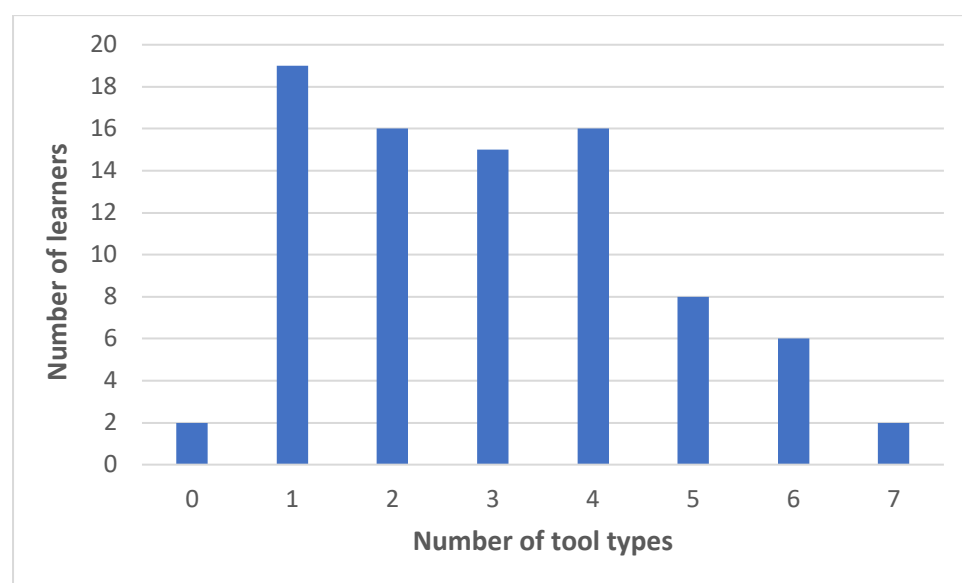


Figure 4. Number of tool types used per number of learners

4.2.3. *Single-tool vs multiple-tool searches.* In order to check whether the information found in a tool tends to be completed and/or confirmed by other tools, we computed the distribution of single-tool vs multiple-tool searches (see Table 3). It appears that learners strongly prefer using single tools individually (84.3% of the searches) over combining tools (15.7% of the searches). The proportion of multiple-tool searches varies considerably across individuals, though: it amounts to 18.1% on average per learner ($sd = 16.1$), with a wide range of variation around that mean, as shown in Figure 5. Multiple-tool searches are also quite varied in nature. Although learners sometimes combine several tools of the same type (e.g. different bilingual dictionaries), this only occurs in 21.1% of the searches. They more often combine two different types of tools (64.7%), while combinations of three (13.8%) or four (4.3%) types of tools also occur. Unsurprisingly, multiple-tool searches involve a bilingual tool in 84.7% of the cases. The other three most common tools used in combination with others are monolingual dictionaries (31.1%), search engines (17.4%), and thesauri (14%).

Table 3. Distribution of single-tool vs multiple-tool searches

Type of search	n	%
Single tool	1,301	84.3%
Multiple tools	242	15.7%
Total	1,543	100%

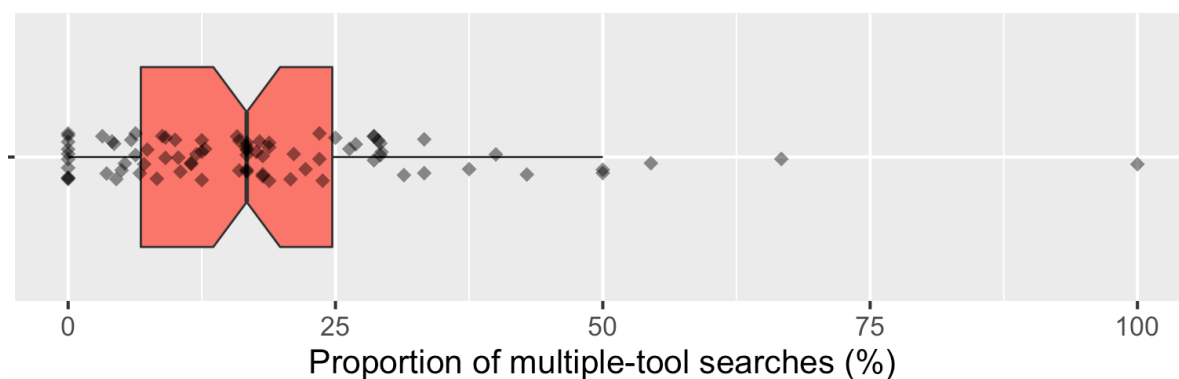


Figure 5. Boxplot of the proportion of multiple-tool searches per learner

When learners resort to multiple tools, it is typically to seek confirmation of the information they found in another tool, or because they did not find the information they were looking for in the first tool they consulted. In some cases, they also combine tools to take advantage of the complementary information provided by different tools. For example, one learner looks up *stress* in Thesaurus.com and then looks up the use of the synonym *emphasis* in the Macmillan Dictionary, which leads to the use of the phrase *lay emphasis on* as it appears in the dictionary. Such combined uses are however relatively rare. The majority of learners adopt simple search strategies, apparently trusting the information they find first, and they do not seem to be aware of the potential of combining tools that are complementary to each other. This seems to be especially the case of learners who rely most heavily on bilingual tools: a linear regression model that sought to predict the proportion of learners' use of bilingual tools as a function of (i) the number of multiple-tool searches and (ii) the proportion of multiple-tool searches reveals that the proportion of multiple-tool searches is the only significant predictor and shows a significant negative correlation between the proportion of use of bilingual tools and the proportion of multiple-tool searches ($R^2 = 0.18$, $p = 0.0001007$).² This suggests that the more learners tend to resort to bilingual tools, the less likely they are to combine tools in their searches.

4.3. *Are online writing tools helpful?*

In the third and final research question, we consider the usefulness of the writing tools and test the assumption that the use of writing tools should help learners write better texts. This is operationalized by the effect of the use of tools (Section 4.3.1) and the correlation between learners' use of tools and the grades they obtained for their written texts (Section 4.3.2).

4.3.1. *Effect of the use of tools.* In an attempt to assess the efficiency of learners' consultation behaviour, we characterized each search using an online writing tool as 'positive', 'negative', 'both', 'none', or 'indeterminate'. Table 4 defines and illustrates these five types of effects.³ As shown in Table 5,⁴ learners' searches have a positive effect in the majority of cases (63.4%), which largely confirms our hypothesis. In about one third of the searches, the effect is (partly) negative (i.e. either negative or both negative and positive) or absent altogether.

Table 4. Definition and example of the different types of effects

Effect	Definition and example
Positive	Search leads to a correct formulation or comes after a correct formulation that is left as is. E.g. A learner looks up <i>néfaste</i> in Reverso French-English and replaces <i>nefast</i> with <i>harmful</i> .
Negative	Search leads to an incorrect formulation or comes after an incorrect formulation that is left as is. E.g. A learner looks up <i>manifestation</i> in the Macmillan Dictionary and leaves <i>manifestation</i> as is when the intended meaning is that of <i>protest</i> .
Both	Search leads to a partly correct and partly incorrect formulation or comes after such a formulation that is left as is. E.g. A learner looks up <i>strive for</i> in Linguee English-French and writes <i>strive for entertaining this important aspect</i> instead of <i>to entertain</i> .
None	Search has no effect on text because the information found is not relevant or not used. E.g. A learner looks up <i>importance</i> in Thesaurus.com but does not find a suitable synonym and leaves <i>importance</i> as is.
Indeterminate	Effect is unclear.

Table 5. Distribution of the types of effects

Effect	n	%
Positive	979	63.4%
None	205	13.3%
Both	175	11.3%
Negative	147	9.5%
Indeterminate	38	2.5%
Total	1,544	100%

Searches with (partly) negative effects can be further categorized according to the problem that is involved. Table 6 defines and illustrates the different categories that were recognized, while Table 7 shows the distribution of these categories among the searches with (partly) negative effects. Stylistic issues (37.3%) are slightly more frequent than formal issues (34.2%), which are more frequent than semantic issues (23.3%). Combinations of different types of problems are relatively infrequent (less than 3% each).

Table 6. Definition and example of the different problems involved with (partly) negative effects

Negative effect	Definition and example
Style	Stylistic errors that include register-related errors and unidiomatic or uncommon language choice. E.g. A learner looks up <i>à toutes les sauces</i> in Linguee and uses the translation <i>loosey-goosey</i> , which is an informal term that does not belong to a formal written register.
Form	Erroneous form of a word or expression, involving for example a spelling error or a (lexico-)grammatical error. E.g. A learner looks up <i>fermer les yeux sur</i> in the PONS Dictionary and writes <i>turn a blind eye on</i> instead of <i>to</i> .
Meaning	Erroneous choice of a word or expression that does not have the intended meaning. E.g. A learner looks up <i>furnish</i> in Thesaurus.com and does not change <i>science and industrialisation furnished tools</i> to <i>supplied</i> or <i>provided</i> (from French <i>fournir</i>).
Combination	A combination of any of the above. E.g. A learner looks up <i>nonsense</i> in WordReference English-French and writes <i>a nonsense</i> (form: should be <i>nonsense</i> , with no article; style: too informal for a written register).

Table 7. Distribution of the problems involved with (partly) negative effects

Negative effect	n	%
Style	120	37.3%
Form	110	34.2%
Meaning	75	23.3%
Form & meaning	9	2.8%
Form & style	8	2.5%
Total	322	100%

4.3.2. *Correlation between use of tools and grades.* With a view to further testing whether writing tools can help learners improve their written production, we correlated learners' consultation behaviour with the grade they obtained for the finished product. The texts were graded as part of the course and on the basis of the Word documents only (videos were not accessible to the graders). Since the essays by the two cohorts of students were graded by different teachers, the grades were normalized via z-scores. By means of a linear regression model, we sought to predict learners' grades as a function of six independent variables, viz. the number of searches, the proportion of searches with a positive effect, the number of tools used, the number of multiple-tool searches, the proportion of multiple-tool searches, and the proportion of use of bilingual tools.⁵ A backwards model selection process yields a model ($R^2 = 0.16$, $p = 0.001379$) with two significant predictors, namely the proportion of searches with a positive effect and the proportion of multiple-tool searches, both of which correlate positively with learners' grades. These two variables may be taken to reflect learners' ability to make good use of resources; their positive correlation with grades suggests that it is not so much the *number* of searches as the *efficiency* of searches that is relevant, and that *combining* several tools in a search is a winning strategy more than just using several tools independently or relying more or less heavily on bilingual tools.

5. Discussion

The analysis of the use of online writing tools in the PROCEED sample has shown that learners tend to spend some 13% of their time consulting online tools and that the searches they carry out are quite quick (lasting only a few seconds) and simple (using a single tool). As hypothesized, it has also underlined the variation among individual learners, who appear to adopt quite different practices as far as consultation behaviour is concerned. The time spent using online tools, the number of searches carried out, the number of tool types used, and the proportion of multiple-tool searches all vary between learners, sometimes to a considerable extent (e.g. from no searches to 49 searches during the writing task). The number of searches per learner and the number of tools resorted to do not appear to correlate with the grade assigned to the text. This supports Bailey and Withers's (2018) finding that there is a great deal of individual variation in the relationship between the number of times that participants use tools and the quality of the written output (a paraphrase, in their study). Two reasons can be put forward to explain this lack of correlation. First, some students are proficient writers and produce high-quality texts without necessarily needing tools to help them. As Bailey and Withers (2018: 185) note, 'it is possible for students to write well without software aids'. Second, using tools does not necessarily mean using them when they should, or using them appropriately. Our results show that learners tend to conduct single-tool searches, but that a higher proportion of multiple-tool searches correlates with a higher grade. Furthermore, the positive correlation between the grade and the *proportion* of searches with a positive effect suggests that efficiency in the consultation behaviour is key.

Efficiency involves using the most appropriate tools for the writer's purposes and being able to combine them to take advantage of their complementarity. However, our analysis has shown that learners tend to stick to the same tool types, among which bilingual tools have pride of place. This latter finding confirms our hypothesis, as well as other studies highlighting learners' preference for such tools, despite their weaknesses (see, e.g., Christianson (1997: 24) on the limitations of bilingual dictionaries). Quinn (2015), for example, reports on a survey in which students claimed that they used bilingual dictionaries more often than any other tools. Laufer (2011: 41) demonstrates that learners mostly relied on bilingual dictionaries to complete a task on verb-noun collocations, although these dictionaries actually 'provided the smallest number of collocations'. Kim (2018: 318) also emphasizes the important role of learners' mother tongue in dictionary consultation, with Korean students in her study almost exclusively using Korean as dictionary entry words. Similarly, learners in our study mostly used a word or phrase in their mother tongue as a starting point for their searches.

Conversely, some other tools whose usefulness has been proved tend to be neglected by learners. Considering that corpora are often seen as more efficient than dictionaries (see, e.g., Boulton 2009 or Mueller and Jacobsen 2015), it is slightly disappointing that learners turn out to use them so little. Online collocation tools have also been shown to be useful to learners (cf. Nurmukhamedov 2017) and collocation dictionaries, despite some limitations, have been claimed to be more helpful than corpora in certain contexts (see McGee 2012). Yet, like corpora, they are hardly ever used by our learners, which corroborates the observation that learners tend not to look up collocations very often (cf. Atkins and Varantola 1997: 15, Lew 2004: 119). There are several possible reasons for learners' tendency to neglect corpus tools and collocation dictionaries. First, learners are less likely to be familiar with these tools than with bilingual or monolingual dictionaries, for example. Thus, Henriksen (2013: 42) points out that 'learners often have no knowledge of collocation dictionaries'. Second, training has been shown to be particularly crucial for the use of corpus tools (e.g. Quinn 2015) and collocation dictionaries (e.g. Kim 2018). Without such training, learners may feel that they are not well equipped to venture on searches involving these tools.

Third, even with training, corpus use is often found to be difficult for learners (e.g. Kennedy and Miceli 2001), which might discourage them from turning to corpora. These elements, possibly combined with each other, may explain why not many learners in our study spontaneously used corpus tools and collocation dictionaries.

On the bright side, it should be underlined that, despite learners' preference for a limited range of tool types, some use one and the same tool for a variety of purposes, hence exploiting the potential versatility of their favourite tools. For example, a learner uses Reverso to (1) find a translation (Fr. *enjeu* > *stakes*); (2) check the use of some phrase, querying *pave the road* to check the preposition that is used with it (*pave the road for* > *to*); and (3) find a synonym, such as for *shiny* by querying Fr. *étincillant*, which leads the learner to replace *shiny* with *sparkling*. It must also be stressed that learners' searches are generally efficient, resulting predominantly in a positive effect, so that, on the whole, it can be said that writing tools help learners improve their texts, as hypothesized.

Yet, a closer examination of the cases in which online writing tools have no effect or a negative effect shows that some of learners' searches could be made more efficient. It thus appears that the production of an incorrect formulation despite the use of a writing tool can be traced back to three main causes, which partly overlap at times. The first one is a lack of attention to detail about the information that learners have found. For example, a learner finds *permanent damage* in Reverso French-English, but then ends up writing *permanent damages* in the text. The second cause is a lack of critical thinking about the information that they retrieve. For example, a learner finds via a Google search that *fiscal paradise* (on the model of French *paradis fiscal*) exists, but does not realize that *tax haven* is actually more common and idiomatic. Similarly, the learner who finds and uses *pursue* as a translation of French *poursuivre* is not aware that it does not apply in the legal context of suing or prosecuting someone. Thirdly, the negative effect may be due to some additional grammatical error that is unrelated to the learner's search, for example when a learner looks up the verb *désigner* in ReversoContext French-English and writes *be designate* instead of *be designated*. In addition to these cases where the tools provide appropriate information but learners fail to take it on board somehow, there are also some cases in which tools do not provide any relevant information about the erroneous use (at least on the basis of the search as it is carried out by the learner). Unidiomatic uses are a case in point. Their presence in the texts despite the use of writing tools can in part be attributed to learners' propensity towards single-word searches, as they often result from the use of words which, taken individually, are perfectly correct, but which, taken together, are not acceptable or do not express the meaning derived from the combined elements. For example, a learner writes *to step up in society*, in the sense of 'climbing the social ladder', after looking up *grimper* (~'climb'), *monter* (~'climb'), and *échelon* (~'level') in a bilingual dictionary, whereas looking up the expression *gravir/grimper les échelons* in a bilingual concordancer would have yielded far more idiomatic alternatives. Finally, although it is a rare occurrence, it sometimes happens that a tool provides erroneous or misleading information. WordReference French-English, for instance, suggests *to weigh up the pros and the cons* in an example sentence as a translation for French *peser le pour et le contre*, while *weigh (up) the pros and cons* (with no article before *cons*) is in fact more common: it occurs 163 times in COCA and 22 times in the BNC, as against 4 and 0 occurrences, respectively, for *weigh (up) the pros and the cons*. Online bilingual concordancers like Linguee or ReversoContext, being based on machine learning rather than thorough lexicographic treatment, may also include incorrect information. Talking about the collaborative dictionary of Reverso-Collins, Granger and Lefer (2016: 292) note that entries for lexical bundles seem to include 'a non-negligible number of literal and/or erroneous translations'.

It is also interesting to consider the other side of the coin, namely cases where learners have not used any online tools, although this would certainly have been useful. The observation of the screencast videos brings out such cases. For example, in the following extract, the learner merely looked up the French word *majorité* in Reverso (after typing *majority*), failing to look up other words that might have made it possible to correct the many errors in the direct vicinity:

- (1) In my point of view, money is in link with the majority of the problems happening currently: war, terrorism, work of children, etc. [...] without money, you can't break out a war, [...], you can't create these arms of evil.

This testifies to some learners' lack of awareness of their difficulties and possibly their overconfidence in their writing skills, as also acknowledged by other scholars (e.g. Frankenberg-Garcia 2011, Laufer 2011).

The misuses of online writing tools and the lack of consultation when it would have been necessary highlight the need to train learners in the use of writing tools (see also, e.g., Yoon 2016b). Before such training can take place, however, it is necessary to make learners aware of the range and value of existing tools, what type of information specific tools do and do not provide, and when they should make use of such tools. The focus should be on aspects of language that appear to be problematic for learners. Our study has shown, for example, that searches with negative effects often involve stylistic issues, which confirms studies that have brought to light learners' lack of register awareness (see Gilquin and Paquot 2008). This suggests that learners fail to look for information about style or that they have difficulty finding such information in the tools they use and with the search strategies they adopt. It may also be that they do not use the most appropriate tools for this type of issue. The tools that they predominantly use, namely bilingual dictionaries, usually do not include any stylistic information, nor do thesauri, which tend to present synonyms as being interchangeable; monolingual dictionaries sometimes include stylistic indications (with labels such as 'formal' or 'spoken'), but these are often not very visible. For stylistic issues, the best tool to turn to is probably a corpus that distinguishes between different genres, such as COCA or the BNC, but as we have seen, corpora are rarely used by learners. Awareness of one's needs and how to fulfil them should thus contribute, together with training and practice, to a more efficient use of writing tools and, ultimately, a better written production.

6. Conclusion

Through the analysis of annotated screencast videos from the PROCEED learner corpus, we have been able to systematically investigate the real-time use of online writing tools among a large sample of learners of English carrying out a free composition task. This analysis has made it possible to answer the three research questions we sought to address. First, we have seen that on average learners spend about 13% of their time consulting online resources and that the number of searches they do varies considerably between individuals (RQ1). It has also been shown that learners tend to stick to a small number of tool types, mostly bilingual ones, and that they usually rely on one single tool to answer a specific question (RQ2). Finally, it turns out that learners' searches are generally efficient; as for the grades attributed to the finished texts, they do not appear to correlate with the number of searches that learners carry out or the number of tools that they use, but rather with the proportion of searches that have a positive effect and with the proportion of multiple-tool searches (RQ3). A closer examination of the videos has also revealed a number of characteristics of learners'

consultation behaviour, for example their lack of critical thinking about the information retrieved from online tools.

The ultimate aim of a study such as this one is to find out what aspects of the use of writing tools are problematic for learners, so as to train them to better use these tools. Relying on a corpus of free compositions analyzed with the techniques of corpus linguistics makes it possible to enhance the degree of ecological validity and of generalization of the study. Thanks to the privileged observation point that screencast videos offer, we are also in a better position to identify learners' actual problems with writing tools and to provide them with appropriate training, which should result in learners' improved writing skills. With the increasing availability of various online tools and writers' growing dependence on such tools, research into learners' consultation behaviour has become more crucial than ever and needs to be pursued and applied. In this endeavour, researchers will require all resources and techniques available. Process learner corpora should be one of them.

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Notes

¹ <https://uclouvain.be/en/research-institutes/ilc/cecl/proceed.html>.

² The three outliers visible in Figure 5, that is, the three learners whose proportion of multiple-tool searches exceeds 50%, were removed from the data after the model was fitted a first time and model diagnostics indicated that these data points severely distorted the distribution of the residuals.

³ Note that when a search occurred after the formulation of some text without any change being made to what had been written, it was annotated as 'negative' or 'positive' in case the search would have been considered 'negative' or 'positive' if the learner had written the same text right after the search. This was done to prevent the chronological order of events from affecting the annotation, since a learner who does a search before writing something that she is unsure about, or a learner who first writes something that she is unsure about and then checks it in a tool, are two scenarios that come down to the same effect of the tool.

⁴ The total in Table 5 is larger than the number of searches because in one instance, a single search has been annotated as having two distinct effects: a learner wrote *technology [...]* *doesn't stop us from dreaming* and *can we say that it impede us from dreaming* in two different sentences in her text and then looked up *empêcher* in WordReference French-English followed by *impede* in WordReference English-French, which then led her to change *stop us from dreaming* to *prevent us from dreaming* (positive effect), but to leave *can we say that it impede us from dreaming* as is (negative effect).

⁵ The variable 'number of searches with a positive effect' as well as two-way interactions had initially been included in the model, but they were removed due to the severe collinearity that they induced as indicated by their variance inflation factor (vif). In addition, three outliers that seriously affected the distribution of the residuals were also removed.

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Appendix: List of tools used by learners (listed in decreasing order of number of queries per tool). When different functionalities of a tool have been used, these are indicated between parentheses.

Tool	Queries
Reverso (bilingual dictionary or concordancer, monolingual dictionary, thesaurus, spell checker)	759
WordReference (bilingual dictionary, monolingual dictionary, thesaurus, forum)	387
Linguee	326
Macmillan Dictionary (monolingual dictionary, thesaurus)	192
Google (search, dictionary, translate, images)	126
Thesaurus.com	115
Word (spell checker, grammar checker, synonyms function)	46
Larousse (bilingual dictionary, monolingual dictionary)	44
Sketch Engine for Language Learning (word sketch, examples, similar words)	36
PONS Dictionary	13
Oxforddictionaries.com	12
Cambridge Dictionary (bilingual dictionary, grammar)	10
Synonym.com	5
Languagetool.org	4
Anglaisfacile.com	3
e-anglais.com	2
Lexilogos	2
Merriam Webster (thesaurus)	2
Oxford English Dictionary	2
Usingenglish.com	2
Antidote	1
Antonyme.org	1
Bing search engine	1
British National Corpus interface on English-Corpora.org	1
Dictionary.com	1
Englishforums.com	1
grammar.yourdictionary.com	1
Ozdic	1
smart-words.org	1
synonymo.fr	1
verb2verbe.com	1
Wikipedia	1
Wiktionary	1