Derivational awareness in late bilinguals increases along with proficiency without a clear influence of the suffixes shared with L1

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Derivational awareness in late bilinguals increases along with proficiency without a clear influence of the suffixes shared with L1. *

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Abstract

Morphological awareness contributes to vocabulary acquisition and reading in bilingual children who learned English after their native language. In line with these considerations, we further investigated L2 processing in late adult bilinguals where questions related to morphology need to be clarified. French-English speakers (N = 92) were assessed for three morphological awareness stages: lexical semantic knowledge, syntactic knowledge, and distributive knowledge. We investigated whether the evolution of morphological awareness was related to L2 proficiency and whether it was facilitated by the presence of suffixes shared in L1 and L2. Our results confirmed the influence of language proficiency at each stage of morphological awareness. However, the hypothesis of an advantage of suffixes shared between French and English was not confirmed as no clear advantage was found for those suffixes. Our findings are discussed in line with the morphological congruence hypothesis and compared with the previous results in the literature.

Introduction

English as a second language

English is the most popular second language (L2) learned worldwide (Ethnologue, 21st edition website). As its acquisition involves economic, political, and social challenges, countries develop strategies to improve their population's proficiency in English. In France, for instance, political measures were taken in 2005 under the "Plan de rénovation de l'enseignement des langues vivantes étrangères" (Plan for the renewal of foreign language teaching) to improve L2 acquisition by encouraging more interactivity between teachers and students. Despite these political measures, France is still only 31st in the EF rankings (2021), as a country with intermediate to high English proficiency. The EF ranking describes intermediate English speakers as able to understand songs' lyrics, to write professional emails on familiar matters, and to take part in meetings. However, such a level does not permit speakers to interact efficiently in a professional context, to fully understand movies and TV shows, and/or to read newspapers. A lower inclusion of English culture in France is likely to explain the discrepancy between France and countries with a higher English L2 proficiency. France has been more protective of its own culture and language than other countries such as The Netherlands, Denmark or Norway, which provide deeper and earlier English immersion. These countries start teaching English to children at a very young age with specific teaching strategies. They encourage exchange programs and provide English media in the original language (movies, TV shows, video games) so that there are many opportunities for out-of-school learning (De Wilde et al., 2020; Leona et al., 2021).

Like most non-English speaking countries, France is characterized by sequential bilingual language acquisition, which is the focus of the current study. Unlike simultaneous acquisition, sequential acquisition happens late in development, typically starting in the last years of primary school. Although official curricula state that English must be taught in elementary school, so that pupils can express themselves with common expressions, the systematic teaching -including both written and oral modalities – only starts in grade 6. At that time, children already have well-established literacy skills in French, mostly acquire English through writing and reading (Cornut et al., 2021), and live in a context where L2 is not much present. We are interested in knowing more about the morphological mechanisms underlying French speakers learning English in such a context.

Morphological awareness

A characteristic L2 learners rapidly notice is that many words take different inflections, depending on the message conveyed. The more forms verbs, nouns and adjectives can take, the more difficult a language is to learn as L2 (the small number of inflections is arguably one of the advantages of English as L2). However, relations between form and meaning also provide advantages when they introduce redundancy and systematicity in a language. This is the case for derivation, where affixes allow language users to express and understand meanings related to pre-acquired concepts. Thus, English speakers can understand words such as “redundancy”, “systematicity” and “derivation” when they know the words redundant, systematic and derive.

English vocabulary includes about ten thousand word families, consisting of stem words and transparent derivations (Brysbaert et al., 2016; Nation, 2006) which implies that many words are complex and composed of more than one morpheme (the smallest meaning-bearing unit of a language; (O’Grady, 1997)). Interestingly, while inflections are given much explicit attention in L2 classes because of the acquisition challenges they cause, the beneficial role of morphological relations is often left implicit (Kotzer et al., 2021). Sánchez-Gutiérrez and Hernández Muñoz (2018) recommended including explicit morphological instruction in

English-Spanish learners, to support the development of morphological awareness abilities (see also Rastle et al., 2021).

In this paper, we focus on derivational awareness (as part of morphological awareness) in L2 speakers, which can be defined as the ability to decompose derived words into roots and affixes (Carlisle, 2000). Derivational morphology refers to word patterns that create new words by either adding meaning and/or changing the syntactic category of a word. For example, the suffix *–ness* can be used to turn an adjective into a noun referring to "the state of" (vividness refers to the state of being vivid). Similarly, one can derive adjectives from verbs by adding the suffix *–able* to indicate the feasibility of an action (e.g., swimmable, washable, thinkable). This process allows language users to express more meanings and helps listeners understand meanings of previously unencountered words (which is more difficult when the derivation does not follow the usual pattern of the language, as in "vanity" or "edible").

Tyler and Nagy (1989) provided an overview of the linguistic and cognitive constraints involved in derivational awareness. Other authors focused on the categorization of tasks (Apel, 2014) or formulated a reading model of morphology (Levesque et al., 2021), but up to now Tyler and Nagy (1989) is the main developmental model making a distinction between three stages: the lexical semantic knowledge stage, the syntactic knowledge stage, and the distributional knowledge stage. The lexical semantic knowledge is the first aspect to be acquired. It refers to the ability to recognize the complex internal structure of words (e.g., "worker" [-stem "work" + affix "-er"]) as well as to notice when two or more words share a common morpheme (e.g., to be able to recognize that amazement shares a morpheme with *amaze* but that *apartment* does not share a morpheme with *apart*). This stage can be evaluated with a judgment task (Casalis & Louis-Alexandre, 2000; Duncan et al., 2009; Kuo &

Anderson, 2006; Nagy et al., 2006) in which participants are asked to evaluate if there is a semantic relationship between pairs of words.

The second aspect of derivational awareness, syntactic knowledge, refers to the ability to identify the syntactic category of a complex word depending on the suffix used. Speakers knowing the adjective *blind* recognize it as an adverb when it is suffixed with *-ly* (*blindly*) and as a noun when suffixed with *-ness* (*blindness*). This stage can be evaluated with a productive task (Carlisle, 2000; Casalis et al., 2009; Desrochers et al., 2018; Kraut, 2015; Lam & Chen, 2018; Ramírez et al., 2013) in which participants are asked to fill in a missing word in a sentence based on a root word (e.g., they are asked to fill in *breakable* in the sentence: "Remember to pack anything ___ in bubble wrap." [BREAK]).

The third and last aspect of derivational awareness is distributional knowledge. This refers to knowing the constraints of morphological combinations. Speakers at this stage understand that not all suffixes can be attached to every base word. For example, they know that *-ness* can be attached to adjectives but not to verbs, while *-able* attaches to verbs but not to nouns. This stage can be assessed with a task in which participants are asked to select an acceptable derivation of a given root word among lures (Deng et al., 2016; Sánchez-Gutiérrez & Hernández Muñoz, 2018). For example, they are asked which derivation of *loud* is acceptable: loudness, loudable, loudify, or loudment.

Derivational awareness, as defined by Tyler and Nagy (1989), refers to the conscious ability to decompose derived words into their counterparts. This is also true for the definition of morphological awareness (e.g., Carlisle, 2000). As morphological relationships can be learned implicitly (i.e., without awareness), other researchers have been motivated to develop implicit tests of morphology knowledge, such as masked priming (Ciaccio & Clahsen, 2020; Rastle & Davis, 2008) or self-paced reading (Jiang et al., 2011). We will return to this issue in the discussion section.

Morphological awareness correlates with language proficiency in L1

Morphological awareness correlates with proficiency in the mother tongue. Studies focusing on monolingual children have evidenced the role familiar morphemes play in the acquisition and use of new vocabulary. In a seminal study, Anglin (1993) showed that children from 6 to 10 year-old use the different morphological structures they acquired to infer word meaning. Later studies confirmed the finding and established the benefit of morphological awareness in monolingual children for vocabulary learning (Kieffer & Lesaux, 2012; McBride-Chang et al., 2008). In addition, morphological awareness is involved in literacy, including spelling accuracy (Casalis et al., 2011; Desrochers et al., 2018; Rispens et al., 2008), and reading fluency and comprehension (Casalis & Louis-Alexandre, 2000; Deacon et al., 2007; Desrochers et al., 2018; Levesque et al., 2019). Note that the contribution of morphological awareness to reading comprehension was also found in adults (Kotzer et al., 2021).

Morphological awareness plays a role in L2 and increases with proficiency

Knowledge about morphological relations benefits L2 acquisition as well. Several studies have documented the contribution of morphological awareness to L2 reading comprehension in children enrolled in immersion programs or studying a L2 in school (D'Angelo et al., 2017; Kieffer & Lesaux, 2008, 2012; Lam et al., 2020; Marinova-Todd et al., 2013; Zhang & Koda, 2014). Fewer studies have addressed the contribution for adults learning L2 in adolescence. Zhang & Koda (2012) reported that Chinese-English adult bilinguals' ability to recognize the root of morphologically complex words contributed both directly and indirectly to L2 vocabulary. On the other hand, it only contributed indirectly to reading comprehension through vocabulary knowledge and lexical inferencing. Along the same lines, Zhang (2021) studied Chinese students acquiring English as L2 and observed that English morphological awareness at the beginning of the academic year predicted reading comprehension ability at the end of the year.

In contrast, several findings suggest that although derivational processing increases as individuals become more proficient in L2, the full skill may be limited to high proficiency levels (Diependaele et al., 2011; Jiang & Kuo, 2019; Kim et al., 2015; Kraut, 2015). Kraut (2015) evaluated morphological awareness in L2 speakers of English (L1s: Chinese, Portuguese, Arabic and Spanish). She found a significant improvement from intermediate to advanced proficient level. Sánchez-Gutiérrez & Hernández Muñoz (2018) also explored the increase of morphological knowledge through four different tasks focusing on detection skills (i.e., relational knowledge) in English-Spanish bilingual university students. Just like Kraut (2015) they highlighted that students who learnt Spanish in a classroom did improve on Spanish derivational awareness over the three years of the study. This was particularly true for tasks that tapped into a low level of procedural complexity. However, despite three years of practice students did not develop a systematic use of morphological knowledge. They improved at the lowest level of difficulty but even highly proficient L2 speakers struggled at the highest level of difficulty. Jiang & Kuo (2019) further confirmed these results. They tested a large group of Chinese-English college freshmen and found that intermediate to highly proficient bilinguals were able to identify word bases in complex words. In addition, highly proficient bilinguals could interpret the meaning of a suffix. All these skills were absent or less developed in low proficiency readers, leading to the conclusion that morphological awareness increased with proficiency. Furthermore, the research highlighted that even highly proficient bilinguals did not make use of morphology to the same extent as L1 speakers.

Transfer of morphological awareness from L1 to L2?

The observation that L2 learners acquire morphological awareness in L2 has raised the question to what extent they can profit from morphological awareness in L1 (Jarvis & Pavlenko, 2007; Kieffer & Lesaux, 2008; Kim et al., 2015; Koda, 2000, 2007; Koda & Miller, 2018; Ramírez et al., 2013). This has been investigated mainly by comparing speakers of different languages acquiring English as L2. For instance, Wu & Juffs (2021) examined morphological awareness for English in native speaking university students, Turkish-English bilinguals and Chinese-English bilinguals. Turkish is a language making extensive use of derivational suffixing, whereas this is not true in Chinese. In line with their predictions, Wu and Juffs (2021) observed better performance on a series of morphological awareness tests in Turkish-English bilingual students than in Chinese-English bilingual students. The Turkish-English bilinguals even outperformed the English native speakers on one test (morphological relatedness, in which participants had to indicate that happy and happiness are related but cat and catalogue not). Kim et al. (2015) explored the same question in native English speaking children and bilingual children with Spanish and Chinese as mother tongue. They unexpectedly found that both bilinguals' groups outperformed native English children on morphological awareness tests, which they attributed to the fact that morphology is more likely to be taught explicitly in L2 classes than in L1 classes (see also Rastle et al., 2021). Most importantly, Kim et al. (2015) found that Spanish-English children outperformed Chinese-English children, which the authors interpreted as a result of Spanish and English having more structural similarities in common than Chinese and English.

Jiang et al. (2011) proposed the morphological congruency hypothesis to explain morphological transfer from one language to another. She compared English bilingual adults (L1s: Russian and Japanese) to native English speakers in a self-paced reading task focusing on inflectional morphology (more specifically, on plural errors). The study highlighted a similar sensitivity to errors involving both plural markers and verbal subcategorization in natives English and Russian-English bilinguals. However, Japanese speakers were only sensitive to verb subcategorization errors. Jiang et al. (2011) interpreted this finding as evidence for the hypothesis that a new morpheme that is incongruent with morphemes known in L1 is harder to acquire than a morpheme congruent with morphemes in L1. As a result, Japanese bilinguals were less sensitive to plural markers, because it is a morphological marker incongruent with their L1. A similar finding was reported by Jiang and Kuo (2019) who observed adverbial suffix learning was easier for Chinese-English bilinguals than verb suffix learning, arguably because of the cross-language differences between the languages.

The present study

The present study was built following Jiang et al. (2011) and Jiang and Kuo (2019) and further investigated to what extent L2 morphological awareness depends on L1 morphological characteristics. We speculated that L2 features absent from L1 will be more difficult to acquire in L2 (also see Callies, 2015). On the contrary, grammatical features existing in L1 should be easier to transfer to L2 (also see Jarvis & Pavlenko, 2008).

In close languages, such as English and French, some morphemes are the same or very similar in both languages. This is the case for the suffixes –age and –able, which are used in both English and French. In contrast, some suffixes are English-specific, for example –less and –ing. Based on the morphological congruency hypothesis (Jiang, 2011), we hypothesized that French learners of English would display better performances in morphological awareness tasks for words with shared suffixes than for language-unique suffixes.

Evidence regarding the importance of shared morphemes in L2 acquisition was published by Lam et al., (2020) with Canadian English-speaking primary school children learning French. The authors assessed awareness of cross-language suffix correspondences (e.g., -ity/-ité) and found that this awareness correlated positively with reading comprehension in L2 after two years of regular French instruction.

We hypothesized that adult L2 learners would profit from morphemic overlap between L1 and L2 to a similar extent as children, certainly at low proficiency levels. We expected that low-proficiency learners would understand derived words with shared suffixes more easily than words with L2-specific suffixes. We also expected that knowledge of derived words with shared suffixes would increase more rapidly as a function of language proficiency than knowledge of derived words with unshared suffixes.

Objectives

In the present research, we addressed two questions: (1) how does morphological knowledge in L2 increase with L2 proficiency, and (2) is the increase faster for morphological relationships shared in L1 and L2? To achieve these aims, we tested French-speaking people of various English L2 proficiency levels on English derived words that either had or did not have French counterparts. Specifically, we predicted that:

- English L2 morphological awareness in French-speaking participants will increase with their English proficiency (see also Jiang & Kuo, 2019; Kraut, 2015; Sánchez-Gutiérrez & Hernández Muñoz, 2018).
- An interaction will exist between proficiency and whether the morphological characteristics are shared with French. For all L2 speakers, we expect that derived words will be easier to process when the derivation exists in the native language as well, but the advantage will be larger for low proficiency L2 speakers (see also Jiang et al., 2011; Kim et al., 2015; Lam et al., 2020).

Methodology

Material

Stimuli

The study consisted of three morphological awareness tasks (see below). For these tasks, we needed 240 English word-pairs (root words and derived words), which were selected from the SUBTLEX-UK database (Van Heuven et al., 2014). We created 3 lists of 80 word-pairs, one unique list for each task. They were all composed of 40 words with shared suffixes and 40 words with unshared suffixes. In two lists, the words with shared and unshared suffixes were matched on length and frequency both for roots and derived words. The last list was composed of pseudowords and only needed to be matched on length. While suffixes were repeated across tasks, no words or pseudowords appeared twice in the experiment. The frequencies of the selected words were retrieved from SUBTLEX-UK. Equivalence of word length and word frequency was checked with the TOST test run with R software (Lakens et al., 2018). This test allows performing two one sided t-tests. One will test the null hypothesis which here assumes that there is an effect. We are thus looking for its rejection ($p<.05$). The other, the alternative hypothesis, will test that the effect falls in the equivalence bounds (lower bounds = -0.4; higher bounds = 0.4). We report one of the sided tests, the one having the smallest test statistic (here, t) with the largest p value.

The derived English words belonged to two categories. The first category (Shared condition) included words whose suffixes are similar in English and French. This category included the following 10 suffixes[i]: -al, -ion, -ment, -ive, -age, -able, -ous, -er, -ure, -ance. The second category (Unshared suffixes) included words whose suffixes only exist in English. This category included the following 10 suffixes: -ly, -ful, -ship, -ness, -y, -less, -ish, -ing, -hood, -th. The number of suffixes used within each condition as well as their length information is available in Supplementary Material.

Suffix productivity refers to the degree to which speakers use a particular suffix frequently and consistently in word formation. Here, we chose the most productive suffixes in English to build three extensive tasks with the same suffixes. The productivity of the suffixes has an impact in monolingual studies (Bertram et al., 1999, 2000) but its impact in bilingual studies seems harder to define because productivity should be considered relative to word formation in both languages. In fact, shared suffixes exist both in English and French which could be used as an argument for more productivity of shared suffixes in French-English bilinguals, even though they might be less productive in English alone. Hence, we chose suffixes that were productive in both the shared and unshared condition so that any effect, if present, would likely to be much smaller than the effect we expected.[ii]

Morphological awareness tasks

We used three morphological awareness tasks each corresponding to a stage of morphological derivation awareness development (Tyler & Nagy, 1989).

The lexico-semantic task (LST)

The lexico-semantic task corresponds to the first stage of morphological derivation awareness (Tyler & Nagy, 1989), addressing lexical semantic knowledge (Kuo & Anderson, 2006; Nagy et al., 2006).

The task was constructed with a total of 80 pairs of words: 40 word-pairs with shared suffixes and 40 word-pairs with unshared suffixes. Each condition contained 20 transparent word pairs (Transparent Condition) and 20 opaque, pseudo-morphological word pairs (Opaque Condition). The transparent word pairs were semantically and morphologically related pairs (e.g., *washable* – *WASH*; *really* – *REAL*) whereas the opaque word pairs were morphologically but not semantically related (e.g., *available – AVAIL*; *gingerly – GINGER*). The full list of word-pairs used in the LST can be found in the supplementary materials. Equivalence of frequencies and length between Transparent and Opaque words was evaluated with the TOST test (Lakens, 2018; see Table 1). We checked whether the difference between the two conditions was significantly larger than d = -.4 and significantly smaller than d = +.4 (i.e., was close to 0). In addition, we asked a group of 20 native speakers to rate the semantic relatedness of the pairs of stimuli on a scale from 1 to 7 points scale. While the semantic relatedness for the transparent pairs was rated at $\bar{x}$= 5.6 (*SD* = 1.7), the opaque pairs were rated at $\bar{x}$= 2.2 (*SD* = 1.7). They were significantly different $t(78) = -18.88$, $p < .001$; d = -4,22.

To increase the likelihood that the words were known to late L2 learners, we made sure that both root words and derived words were frequent ($\bar{x}_{\text{frequency}}$: Zipf = 4.4 and $\bar{x}_{\text{frequency}}$: Zipf = 3.6 respectively). The Zipf scale of word frequency is a logarithmic scale roughly ranging from 1 to 7, with 1-3 representing low frequency words (with a frequency of 1 per million words or less) and 4-7 representing high frequency words (with frequency of 10 per million words or more; see Van Heuven et al., 2014, for more information). Derived words were matched on frequencies ($t(77.11) = 1.73$, $p = 0.04$) and length ($t(75.32) = -1.92$, p = 0.029, respectively) and length according to the TOST test. Root words were also matched on frequencies ($t(77.99) = 1.74$, $p = 0.04$) and length ($t(77.22) = 1.67$, $p = 0.049$, respectively) Frequencies and length of roots and derived words, as well as the results of the equivalence tests, are summarized in Table 1.

The LST comprised 80 questions. For each pair of words, participants were asked to choose one answer among three (“YES”, “NO” or “NO ANSWER”) to indicate whether the words of the pair were connected/linked semantically to each other. Participants were invited to use the last answer option only if they had no idea at all regarding the connection between the words, and/or if one or two of the words were unknown. Participants were invited to respond spontaneously. For each participant, all word pairs were presented on a single page, in a random order generated by the online software LimeSurvey.

<insert Table 1 about here>

The word completion task (CT)

The word completion task corresponds to the second stage of morphological derivation awareness (Tyler & Nagy, 1989), that is syntactic knowledge (Carlisle, 2000; Casalis et al., 2009).

The CT was a production task in which participants had to complete 80 “fill-in-the-blank” sentences. To complete each sentence, a root word was proposed, and participants had to write the proper derived word. For instance, the participants were presented with the sentence “BREAK. Remember to pack anything _ _ _ _ _ _ _ in bubble wrap.” and had to fill in “breakable”. Sentences were retrieved from the website wordreference.com with the agreement of the website’s owner. Details of the word lists, and the sentences used for the CT are available in Supplementary Material.

For the CT task, we used 80 new word pairs. All pairs consisted of a root word and its derived word. Root words were highly frequent (Zipf $\bar{x}_{\text{frequency}} = 4.3$) while derived words were moderately frequent (Zipf $\bar{x}_{\text{frequency}} = 3.4$) hence, probably less familiar. Derived words were matched on frequencies ($t(76.17) = 1.86$, $p = 0.03$) and length ($t(73.81) = -1.92$, $p = 0.029$). Root words were also matched on frequencies ($t(77.4) = 1.86$, $p = 0.03$) and length ($t(53.71) = -1.86$, $p = 0.03$). . Frequencies and length of both roots and derived words as well as results of equivalence are summarized in table 2. Among the 80 pairs, 40 were shared with French (e.g., breakable – BREAK) and 40 were not shared (e.g., womanhood – WOMAN).

<insert Table 2 about here>

The suffix detection task (SDT)

The Suffixation detection task corresponds to the third stage of morphological derivation awareness (Tyler & Nagy, 1989); that is distributional knowledge.

The SDT consisted of 80 multiple-choice questions. Each question contained the root word (e.g., THINK / WIDOW) and four possible derived words. Among the four, only one was a correctly derived word (e.g., *thinkable* / *widowhood*). The alternatives were three pseudowords serving as distractors. One distractor was a pseudoword with a shared suffix (e.g., *thinkal* / *widowure*), the second was a pseudoword with an unshared suffix (e.g., *thinky* / *widowless).* And the third distractor was a pseudoword with an ending dependent on the shared/unshared status of the correct derived word (unshared if the latter had a shared suffix and shared in the opposite case). It aimed to balance the number of shared and unshared suffixes within one trial (e.g., *thinkdom* / *widowine*). The full list of suffixes and details of the tasks' word list are available in Supplementary Materials.

Half of the stimuli (40 items) belonged to the Shared suffixes condition (e.g., eatable – EAT) and 40 to the Unshared suffixes condition (e.g., godhood – GOD). To evaluate participants' distributional knowledge, we chose to focus on derived words with frequencies as low as possible ($\bar{x}_{\text{frequency}}$ = 2.1) and on root words with moderate frequencies ($\bar{x}_{\text{frequency}}$ = 4.1). For this task, we could not fully match the frequencies and lengths of the lists for two reasons. First, the task mainly contained pseudowords. Second, the purpose of the task itself (proposing rare, derived words coming from frequent root words) made it difficult to perfectly match the Shared and Unshared suffix conditions. Frequencies and lengths as well as the tests of equivalence for the Shared and Unshared suffix words pairs are summarized in table 3.

<insert Table 3 about here>

Evaluation of participants' language skills

Participants' language proficiency was evaluated with three tasks. The first one was a Translation task broken down into 3 levels of difficulty (Beginner level, Intermediate level, and Expert level). Each level contained 25 words to be translated from French (L1) to English (L2; Casalis et al., 2015). Details of the task are available in Supplementary Materials. Words were always presented in the same order for each level. The Cronbach alpha for this task was $\alpha = .96$ (with 4 items dropped because of lack of variance, i.e., these items were always answered correctly).

The second task was LexTale (Lemhöfer & Broersma, 2012), a yes/no lexical selection task to assess participants' level of English and their vocabulary knowledge. A random list of 40 words and 20 pseudowords was presented to participants who had to indicate which word they knew. Participants were informed that not all stimuli were existing words and that they would be penalized if they selected non-existing words as "known". Words were presented in the same random order to all participants, on the same page. Cronbach alpha for this task was $\alpha = .83$ (with 10 items removed because they correlated negatively with the total scale). The correlation between the Translation task and LexTale was $r = .66$.

The third task was a Questionnaire of English personal history (based on Li et al., 2017). It consisted of a subjective questionnaire about participants' learning and practicing experiences in English. For instance, participants were asked when they started to acquire English, how much they practiced English every day, if they had travelled abroad for more than three months, and what their subjective perspective was about their level in English. Details of the questionnaire are given in Supplementary Materials.

Procedure

Participants were recruited through media announcements. All tasks were run online and together took about an hour. To access the experiment, participants were given a link that would lead them to the experiment handled by the software LimeSurvey. They were directed to a “welcome page” where they had access to the information letter. They were asked to give their consent to participate by pressing the “START” button. Before starting the study, participants were asked to take the tests in a quiet place equivalent to the conditions they would experience if they did the tests on the university campus.

The study began with the Questionnaire of English personal history. Then participants successively completed the LST, the CT, the SDT, the Translation task and finally LexTale. Items were randomized in the three morphological awareness tasks while they were not in the Translation and LexTale tasks for which the order mattered.

Participants

A total of 92 native French-speaking participants ($\bar{x}_{\text{age}} = 24.4$, $SD = 3.86$, of whom 50 women) were recruited online through media announcements and word of mouth. All participants were raised as French monolinguals. Forty-four participants (47.8 %) were completing a master’s degree, 16 participants (17.6%) were completing an undergraduate degree, 20 participants (21.7%) had a bachelor’s degree, and 12 participants (13.0%) another type of degree (2 participants had a youth worker diploma, 7 participants a PhD, 1 participant a high school degree, and 2 participants an advanced technician’s certificate).

Participants were recruited according to two criteria: their mother tongue (French native speakers) and at least some knowledge of English. Participations were voluntary and without compensation whatsoever.

Participants' level of English was assessed with LexTale (Lemhöfer & Broersma, 2012). LexTale allows conversion of the numerical results in line with the Common European Framework of Reference (Capel, 2012), which divides language proficiency into six levels:

- A1: Understand and use a few familiar everyday expressions.
- A2: Communicate in simple and routine tasks.
- B1: Deal with situations that are familiar and of personal interest.
- B2: Interact with a degree of fluency and spontaneity that makes regular interaction with native speakers possible without strain for either party.
- C1: Express ideas fluently and spontaneously in a multitude of contexts without much obvious searching for expressions.
- C2: Close to native language use; Summarize information from different spoken and written sources can reconstruct arguments and accounts in a coherent presentation.

The LexTale results indicated that 12 participants (13%) had a B1 level in English or lower, 50 participants (54%) had a B2 level, and 30 participants (33%) had a C1-C2 level. In the results section, LexTale results were centered to fit the mixed model analysis. On the centered scale (used in the graphs), the B1 level ranges from *-27* to *-14,* B2 from *-13* to *6,* and C1-C2 from *7* to *22*.

On average, participants started to be exposed to English at the age of 8.7 (*SD* = 2.4). They estimated their level to be sufficient (4.5/7, *SD* = 1.4). Details regarding their subjective

English proficiency and age of exposition in reading, writing, speaking, and listening are summarized in Table 4.

A group of 32 participants considered themselves as reasonably proficient French-English bilinguals (35%). We investigated how they acquired English as L2 through a multiple-choice question. On this question, 7 participants (22%) chose social interactions as their main source of learning, 5 participants (16%) chose school education, 19 participants (61%) chose both social interactions and school education, and finally, 12 participants (38%) indicated that media (TV, internet video-games) and personal experiences (travelling, reading) were the sources that helped them acquire English. [iii]

<insert Table 4 about here >

Results

Statistical analyses were conducted using R software, version 3.5.1 (R Core Team, 2019) and R Studio, version 1.1.456 as well as Jamovi software (2020) for the signal detection analysis. In this study, data were analyzed using linear mixed-effects models (LME; Baayen et al., 2008). This type of analysis was chosen because it allows analyzing data accounting for both subjects' and items' variability (Barr et al., 2013; Judd et al., 2012). Because our data were binary (correct/wrong), we used a binomial generalized linear mixed-effects model, using the glmer function of the lme4 1.1-21 package (Bates et al., 2019). Data and analysis programs are available at the following link: https://osf.io/cv8ny/?view_only=9280aef40d084ceeade43bcbbd8dbf98

Before we look at the individual tasks, Table 5 shows the means and standard deviations for the three tasks and the two proficiency tests. We also looked at the stability of the individual differences. To do so, we calculate Cronbach's alpha for each task. For LST it was .91, for CT it was .98, and for SDT it was .90. This indicates that there were reliable differences between participants. Furthermore, we conducted a correlation analysis between the three various measures. These are shown in Table 5 as well. The correlations were all high ($r > .65$), indicating that all tests largely measured a single proficiency. This was confirmed in a confirmatory factor analysis, which showed that the intercorrelations were accounted for with a single proficiency factor ($\chi^2(5) = 5.72$, $p = .33$; RMSEA = .04).

< insert Table 5 about here >

Lexico-semantic task (LST)

We started by analyzing the data of the Lexico-Semantic task (LST), in which participants had to indicate whether a root word and a “derived” word were semantically related or not (*washable* – *WASH* vs. *available* – *AVAIL*). We used a LME model with three fixed-effect factors for which we analyzed the main effects and their interactions: Condition (type of pair: Transparent/Opaque - discrete categorical variable, contrast coding [-0.5, +0.5]), the Suffix (Shared with French, Unshared – discrete categorical variable, contrast coding [-0.5, +0.5]),) and the participants’ Proficiency in English as measured with LexTale (continuous numerical variable, centered to measure the interaction more accurately). As random-effect factors, the model included random intercepts for participants and items; it also included random slopes by participants for Condition. This model explained the most important part of the variance of our dataset. Further and more complex models failed to converge.

The analysis returned a significant main effect of Condition (estimate = -0.47, SE = 0.15, $z = -3.087$, $p = 0.002$) with more correct responses on the Transparent trials than the Opaque trials. There was also a main effect of Proficiency (estimate = 0.08, SE = 0.01, $z = 10.752$, $p < .001$) with better performance for participants with high proficiency in English as measured with the LexTale (the same result was found with the Translation task). The main effect of Suffix was not significant (estimate = -0.121, SE = 0.13, $z = -0.87$, $p = 0.383$), but the interaction Suffix x Proficiency was significant (estimate = -0.01, SE = 0.003, $z = -2.65$, p =

0.008). As shown in Figure 1, this interaction shows that performance grew faster as a function of L2 proficiency for the Unshared suffixes between English and French than for the Shared suffixes. The interaction Condition x Proficiency was also significant (estimate = -0.02, SE = 0.01, z = _2.84, p = 0.004), because high proficiency participants were better on the Transparent trials (yes-responses) than on the Opaque trials (no-response), as shown in Figure 2. The interaction Condition x Suffix x Proficiency was not significant (estimate = -0.007, SE = 0.03, z = -0.22, p= 0.824).

<insert Figure 1 about here>

<insert Figure 2 about here>

Because the LST data were the outcome of vocabulary knowledge and a bias to say "yes" or "no", we ran an additional signal detection analysis, which allows us to disentangle sensitivity (word knowledge) from response bias (Stanislaw & Todorov, 1999). For each participant, we calculated hit and false-alarm rates for both the shared and the unshared conditions to calculate sensitivity (*d'*) and bias (*c*). Sensitivity was found by subtracting the z-transformed proportion of incorrect "yes" responses to Opaque items (false-alarms) from the z-transformed proportion of correct "yes" responses to Transparent responses (hits). The bias was calculated by dividing the sum of hits and false alarms by two. Sensitivity and bias were calculated separately for the stimuli with suffixes shared in English and French, and for the stimuli with unshared suffixes.

A generalized linear model was used for the analysis of *d'* and *c*. The analysis comprised two fixed factors, Suffix (contrast: -0.5, +0.5) and Proficiency. The analysis for *d'* returned a significant main effect of Suffix (estimate = 0.54, SE = 0.13, $\chi^2(1) = 17.32$, $p < 0.001$) with more correct responses on the trials with unshared than with shared suffixes. There was also a main effect of Proficiency (estimate = 0.08, SE = 0.01, $\chi^2(1) = 173.97$, $p <.001$) with better performance for participants with high proficiency in English. The interaction Suffix x Proficiency was significant (estimate = 0.03, SE = 0.01, $\chi^2(1) = 6.03$, p = 0.014) as shown in the figure 3. In line with Figure 1, it indicated that performance increased more as a function of language proficiency for the unshared suffixes than for the shared suffixes. This result is in line with our second prediction according to which low proficiency L2 speakers will be more dependent on L1-L2 similarity than high proficiency speakers.

The analysis for bias *c* returned a significant main effect of Suffix (estimate = -0.23, SE = 0.06, $\chi^2(1) = 16.10$, p < 0.001) with a stronger bias to say "yes" on trials with suffixes not shared in English and French than on trials with shared suffixes. There was also a main effect of Proficiency (estimate = -0.01, SE = 0.01, $\chi^2(1) = 6.53$, p 0.011) with a stronger bias to say "yes" in high proficiency participants than in low-proficiency participants. The interaction Suffix x Proficiency was not significant (estimate = -0.00, SE = 0.01, $\chi^2(1) = 0.29$, p = 0.593) as displayed in the figure 4.

<insert Figure 3 about here>

<insert Figure 4 about here>

Completion task (CT)

In the CT participants had to fill in the correct derived word given a context sentence and a root word. The data were also analyzed with a LME. The model incorporated two fixed factors for which we analyzed the main effects and the interaction: Suffix (Shared, Unshared – discrete categorical variable, contrast coded) and Proficiency (continuous numerical variable, centered). As random effects, our model included random intercepts for participants and items and slope by participant for Suffix.

The main effect of Proficiency was significant (estimate = 0.145, SE = 0.01, *z* = 11.26, p <.001) with better performances for participants with high proficiency. Neither the main effect of Suffix (estimate = 0.06, SE = 0.19, *z* = 0.31, p= 0.755) nor the interaction Suffix x

Proficiency were significant (estimate = -0.002, SE = 0.004, z = -0.7, p = 0.491), as can be seen in Figure 5.

In a further exploratory analysis limited to the words with shared suffixes, we made a distinction between cases in which the English words and their French translations used the same suffix (breakable – cassable) or not (avoidance –évitement), to see if this distinction would make a difference. This was not the case, as we found 43% correct responses for fully overlapping suffixes against 51% for non-overlapping shared suffixes.

<insert Figure 5 about here>

Suffix detection task (SDT)

In the SDT, the participants had to select the correct derivation of a root word among three decoys. The LME analysis (same as for CT) gave the following results. The main effect of Proficiency was significant (estimate = 0.06, SE = 0.01, z = 10.82, p <.001) with better performance for participants with high proficiency than low proficiency. The main effect of Suffix was not significant (estimate = -0.02, SE = 0.13, z = -0.17, p= 0.88), but the interaction Suffix x Proficiency was significant (estimate = -0.01, SE = 0.003, z = 2.18, p = 0.03). Visual inspection reveals a better performance on the unshared trials for participants with low proficiency but similar performance for both types of suffixes for the participants with high proficiency (see Figure 6). No post hoc could be conducted due to the continuous nature of the proficiency variable and no other effects came out significant.

<insert figure 6 about here>

Power analysis[iv]

Power analysis is becoming increasingly important in research on bilingualism. Hence, we were interested in knowing how much power our design had to detect differences at the population level. The best way to explore this is by using simulation. We illustrate the approach with the Completion Task (CT), as we think this is the one that most resembles usual language processing conditions.

Assuming no difference between the shared and the unshared suffixes, we can consider the completion task as a Rasch model in which 92 participants respond to 80 stimuli. Whether or not a particular participant gave a correct response to a particular stimulus depends on the ability level of the participant and the difficulty level of the stimulus. A Rasch analysis calculates these values. We used the ltm() package in R (Rizopoulos, 2006) and found that the data could indeed be captured quite well with a traditional Rasch analysis, with participant abilities ranging from -4 to +4, and item difficulties from -2.5 to +2.5 (R code for all analyses can be found at the osf website). This allowed us to generate new datasets with the eRm package in R (Mair & Hatzinger, 2007). Assuming a rectangular distribution of participants between -4 and +4, and a rectangular distribution of items between -2.5 and +2.5, resulted in data that strongly resembled the data obtained in the experiment. The rectangular distributions reflect the investments we made to have participants of very different ability levels, and items distributed across the entire range. To finalize the simulation, we created a proficiency index that correlated $r = 0.7$ with the participant ability used to create the Rasch data. This reflects the imperfect validity of our proficiency measures (if this is not done, there is no variability left in participants' intercepts, as there is a perfect correlation between proficiency and participant intercept).

A first simulation with no difference between the two suffix conditions confirmed that the mixed-effects analysis we ran was appropriate. Recognition rates corresponded largely to the rates found in the experiment, and power of the main effect of suffix and the interaction with proficiency were around the alpha level of .05. Increasing the difference between shared and unshared suffixes by making the stimuli with shared suffixes $d = .4$ easier (so that they ranged from -2.9 to +2.1) increased the power of the main effect to .23; the interaction stayed at .05. Further increasing the difference between shared and unshared suffixes gave power = .69 for d = .8, and power = .87 for d = 1.0. For each simulation, the interaction effect stayed at the alpha level. The effect of proficiency was always significant. So, the completion task we used was able to pick up suffix effect sizes larger than d = .8 but was not precise enough to consistently pick up smaller effect sizes.

A similar analysis of the lexico-semantic task (with proficiency and suffix condition as fixed effects) showed that this task required a two-parameter model (with changes in stimulus discrimination in addition to stimulus difficulty). A good approximation of the data was obtained by having participants vary between -2 and +2 (different values are needed because now the guessing level was .25 instead of 0) and stimuli between -2 and +1. Simulating data according to these parameters resulted in data patterns similar to those obtained in the experiment and the expected power of alpha = .05 when there was no difference between the suffix conditions. Power reached .78 when d = .6. At the same time, we observed that there was an elevated significance level of .15-.20 for the interaction between suffix condition and participant proficiency. Half of the time, the proficiency effect was larger for the unshared suffixes than for the shared ones, whereas half of the time the difference was reverse. This suggests that we should be cautious interpreting significant interactions between proficiency and suffix condition in LST.

The suffix detection task is expected to have power similar to the other two tasks. However, it is not clear how much the task adds, given that all three tasks were obtained from the same sample of participants.

Discussion

Morphological awareness is defined as the ability to decompose words consciously into their components (Carlisle, 2000). It is a skill that helps increase vocabulary and reading comprehension in monolingual children (McBride-Chang et al., 2008; Rispens et al., 2008). Several studies addressed the matter in bilingual children, who are schooled at least partially in their L2, and showed that morphological awareness also helps the development of a L2 (Altman et al., 2018; D'Angelo et al., 2017; Kieffer & Lesaux, 2008, 2012; Kim et al., 2015). Data regarding adult bilinguals, who learned L2 at school with small exposure to L2, are more recent and the role of morphological awareness in L2 is less evident (Jiang & Kuo, 2019; Koda & Miller, 2018; Kraut, 2015; Sánchez-Gutiérrez & Hernández Muñoz, 2018; Wu & Juffs, 2021).

According to Tyler and Nagy (1989), three developmental stages can be identified in derivational awareness: lexical semantic knowledge, syntactic knowledge, distributional knowledge. The methodology used in studies on late bilinguals has yet to explore all these aspects simultaneously. To have a clearer view of the evolution of morphological awareness in L2, we chose to use three tasks, one for each stage. The first question we wanted to address was whether L2 proficiency was related to every stage of morphological awareness. The second question was whether shared suffix structures between L1 and L2 are better understood than suffixes unique to the L2. This question was inspired by the morphological congruency hypothesis of Jiang (2011), which holds that a morpheme with a similar function in the mother tongue is easier to acquire in L2 than a morpheme that does not exist in the mother tongue. We expected that cross-linguistic similarity would benefit the development of derivational awareness.

As for proficiency, we found that it influences all stages of morphological awareness. Scores noticeably improved with proficiency in the three tasks we used. This finding is consistent with the results observed by Kraut (2015) who found that the ability to make explicit use of morphological knowledge in English improves with proficiency level. The learning process is gradual with lower performances at low proficiency level and increasing with the level of proficiency. Moreover, evidence can be drawn from the difference observed between Transparent and Opaque words. As proficiency increases, bilinguals' speakers appear more sensitive to composed words. Higher proficiency could underline a better distinction of bases and suffixes. A further interesting finding is that high-proficiency French-English speakers were not reaching ceiling level. This finding is in line with Jiang & Kuo (2019) who found that although morphological awareness improves with proficiency, highly proficient Chinese-English bilinguals still seem to treat highly frequent bases as low frequent bases. In English-Spanish bilinguals, Sánchez-Gutiérrez & Hernández Muñoz (2018) reported that even after three years of study, high proficiency L2 speakers did not develop a systematic use of morphological knowledge. This study, which focused on lexical semantic knowledge, showed that derivation seems hard to grasp for language learners. We find similar results in the present study, using more extensive measures, with 80 word-pairs per task. We tested participants from A1-level up to C2-level. From visual inspection, it looks as if morphological awareness is not present before stage B2 (when L2 speakers can interact with a degree of fluency and spontaneity that makes fluid interactions with native speakers possible). An interesting extension will be to see how well native speakers perform on our tasks relative to C2 bilinguals. Based on the existing evidence, we expect them to do better but probably not at ceiling level either (Kim et al., 2015; Kraut, 2015).

Even more interesting is that performance on the morphological tasks closely follows performance on the vocabulary tests (LexTale and Translation), as shown in Table 5. This finding suggests that morphological awareness is strongly related to vocabulary knowledge, as has been argued in previous studies (in L1: Carlisle, 2000; Nagy et al., 2006; in L2: Gottardo et al., 2018). Gottardo et al. (2018) found that morphological awareness and vocabulary shared a large degree of variance and suggested that the contribution of morphological awareness to reading comprehension may be mediated by vocabulary. If so, this would suggest that known derived words are stored independently in the learners' lexicon. A different position was taken in a recent article by Wu and Juffs (2021). These authors reported that Turkish-English bilinguals significantly outperformed Chinese-English bilinguals in English derivation, morphological relatedness, and suffix-ordering, even when differences in proficiency were considered. The Turkish group even outperformed a native English group in the morphological relatedness task, which the authors ascribed to the extensive use of suffixes in Turkish. Wu and Juffs (2021) further advised researchers to use tasks with pseudowords for the exploration of morphological awareness in bilinguals independent of lexical/vocabulary knowledge, as pseudowords, by definition, do not have a representation in the mental lexicon. This would be an interesting extension of the present research.

Our second research question was whether derivational awareness is better for suffixes shared with L1 than for suffixes unique to L2. Based on the morphological congruency hypothesis, we expected such a difference, certainly at low proficiency levels. Shared suffixes would be easier to acquire than unique suffixes because of L1-to-L2 transfer. This, however, is not what we found: There was no consistent advantage for English words with shared French suffixes. Only the lexico-semantic task (LST) displayed a pattern that could be wrung in line with the predictions (Figure 1). However, part of the shared suffix effect in LST was due to a bias for saying no to words with shared suffixes (Figure 4). In this task, French-English bilingual students hesitated more about saying yes to words with shared L1-L2 suffixes if they did not recognize the stimulus as familiar (possibly because they anticipated trick items). Furthermore, simulations suggested that chances of finding a spurious interaction effect tended to be relatively high in this paradigm (20% instead of 5%). Finally, the effect was not corroborated in the other tasks. There was no interaction at all in the word completion task (CT; Figure 5) and an interaction in the *opposite* direction in the suffix detection task (SDT; Figure 6). We expected shared suffixes to benefit all stages of derivational awareness, particularly so for bilinguals with limited knowledge of L2.

We can think of several reasons why we did not observe the expected distinction between shared and non-shared suffixes. First, the L1-to-L2 transfer of morphological awareness could depend on the how morphologically rich the L1 is (Ciaccio & Clahsen, 2020; Jarvis & Pavlenko, 2008; Kieffer & Lesaux, 2008; Kim et al., 2015; Koda, 2000, 2007; Koda & Miller, 2018; Ramírez et al., 2013; Wu & Juffs, 2021). In this view, the transfer would result from the overall morphological complexity of L1 and not from specific morphemes used in both languages (Wu & Juffs, 2021). What would be relevant is the awareness that words can be derived from other words and not the specific suffixes used in the languages. Deng et al. (2017) published evidence that bilinguals can decompose complex L2 words on the condition that they possess a high level of morphological knowledge in L1. Within this view, morphological awareness in L2 depends on the degree of morphological knowledge attained in L1 rather than on whether suffixes are shared in the languages.

A second reason why we failed to find the expected effect may be that the effect was too small to pick up in our studies. As shown by the power simulations, our experiments were not able to reliably pick up differences of $d = .4$ or smaller, even though we tested 92 participants on 40 stimuli per condition. To assess the severity of this shortcoming, it is important to keep in mind that we were investigating one of the biggest effect sizes in psychological research: the difference in vocabulary size between L1 and L2 speakers. Effect sizes of $d > 2.0$ are common here (e.g., Brysbaert, 2013), as can also be seen in the results we obtained. Performance on the tasks ranged from virtually at random to nearly perfect. Therefore, we expected quite clear differences between shared and non-shared suffixes as well and we can be quite sure that such effects do not exist. Small differences can be of theoretical interest, but do not have the practical relevance we foresaw.

A third explanation why we did not find the expected difference between shared and non-shared suffixes could be due to schooling. As indicated in the introduction, the benefit of morphological overlap is often left unmentioned in classes (Rastle et al., 2021; Sánchez-Gutiérrez & Hernández Muñoz, 2018). Because of this oversight, students may be deprived of useful strategies to cope with the new language they try to master. Possible benefits of explicit morphological instructions are a worthwhile investigation with tasks such as those used in the present article.

A final reason why we failed to obtain a difference between shared and non-shared suffixes may be that we did not use the best task, even though the tasks we used are quite prominent in current research. Above, we already referred to Wu and Juffs's (2021) suggestion to use pseudowords to avoid the problem of lexical contributions to morphological knowledge. Another possible weakness of the tasks we used may be that derivational overlap could be both a help and a hindrance for good performance. This is particularly true for the two tasks with unclear data (LST and SDT). The fact that -*able* is shared between English and French does not help to decide that *available – AVAIL* are **not** related to each other. The same could be true for deciding that *billionable* is not a possible derivative of *billion*. If so, a better task may be one in which morphological overlap is always helpful, such as reading for text comprehension. This could be examined with self-paced reading (SPR) or eye tracking.

Jiang (2011) used SPR to examine differences in sensitivity to inflectional morphology between bilinguals with different L1s. Elgort et al. (2018) used eye tracking to investigate L2 word learning. They asked Dutch-English bilinguals to read an English text of 12 thousand words containing 14 new English words that were presented several times (up to 40 occurrences). Participants' eye movements were tracked, and Elgort et al. (2018)

documented how word reading times decreased as a function of repetition, with fast speeding during the first 8 encounters and slower improvement later on.

Using SPR or eye tracking, we could compare the learning of new English L2 derived words with suffixes shared or not with French. If the findings of the present study replicate, we expect no difference between both types of words. This is the opposite of what the L1 transfer hypothesis predicts. According to this hypothesis, reading and understanding derived words with shared suffixes should be easier than reading and understanding words with unique suffixes. Such a reading study would be a nice complement to the study presented here.

Altogether, the present study revealed several interesting findings for adult late bilinguals. The results were not in line with our prediction that derived L2 words with a suffix existing in L1 would be easier to process (in line with the morphological congruence hypothesis). Further research with more sensitive tasks is needed to see whether the lack of transfer from L1 to L2 is a general phenomenon or applies only to the tasks we used. At the same time, our results are in line with the existing literature by demonstrating a strong correlation between language proficiency and morphological awareness. Future studies may benefit from developing word learning paradigms to shed light on the processes involved in the use of morphological information in L2.

Supplementary material

For supplementary material accompanying this paper, visit https://osf.io/cv8ny/?view_only=9280aef40d084ceeade43bcbbd8dbf98

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Footnotes

[i] The suffixes “-er” and “-ous” in English are equivalent to the the suffixes “-eur” and “-eux”, respectively

ii We thank a reviewer for this suggestion

[iii] The question was multiple choice and participants could select more than one alternative, which explains why the percentages exceed 100% (there were 43 selected alternatives in total).

[iv] We thank the editors of the journal for requiring this information.