SOUND-SPELLING CORRESPONDENCES IN FL INSTRUCTION: SAME SCRIPT, DIFFERENT RULES

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Auditory perceptual and orthographic confusions challenge foreign language (FL) learners. Hearing first-language (L1) learners establish reliable acoustic parameters for sound categories during infancy (Strange, 2011; Werker & Tees, 1984), before learning how to encode them orthographically. In contrast, FL classrooms simultaneously expose adult learners to new second language (L2) sounds and new orthography, a process which is fundamentally different from L1 alphabetic literacy. Even if both employ the "same" script (e.g., Roman alphabet), grapheme-phoneme correspondences (GPCs) are not *congruent* between languages, and languages differ in internal *consistency* of GPCs. Perceptual categories for FL are not robust, requiring greater attentional resources to distinguish L2 phonetic contrasts (Strange, 2011), and likely influenced by the L1, and learners' GPCs are influenced by the L1 (or prior L2s), especially when languages share a script (e.g., German, English). Interaction between orthography and acquisition of L2 sound categories is widely acknowledged, yet poorly understood. We review L2 segment perception research, alphabetic literacy, and early-stage FL instruction, then present results from a longitudinal study of 19 adult FL students beginning to learn German. Prior to instruction, participants spelled 92 auditorily-presented German words featuring 19 phones (9 consonants, 10 vowels). After one semester, they spelled 92 words from course vocabulary lists and 92 unfamiliar words with the same GPCs. We analyze spelling responses to characterize GPC development in FL and generalizability of early gains to novel words.

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INTRODUCTION

First language (L1) phonological acquisition begins prenatally, but L1 orthographic acquisition follows later, when the phonology is well established (e.g., Bassetti, Hayes-Harb, & Escudero, 2015; Cook & Bassetti, 2005; Kisilevsky et al., 2009; Werker & Tees, 1984). When adults begin learning a foreign language (FL) in a formal instructional setting, they typically encounter the phonology and orthography simultaneously. Prior to second language (L2) exposure, naïve listeners rely on cross-language speech perception, whereas learners in a FL context are fundamentally different in that they are L2 learners (Best, 1995; Best & Tyler, 2004). By extension, FL learners who have previously learned one or more L2s are third language (L3) learners. The present study investigates L2/L3 acquisition of German grapheme-phoneme correspondences (GPCs) by adult L1 English speakers in Western Canada, who often have prior (literate) exposure to L2 French before learning German at university.

LITERATURE REVIEW

As shown by research with alphabetically non-literate participants, phonological awareness is largely literacy dependent (e.g., Castro-Caldas, Petersson, Reis, Stone-Elander, & Ingvar, 1998; Dellatolas, Braga, Souza, Filho, Queiroz, & Deloche, 2003). Accordingly, L2 writing system learning scenarios are typologically diverse (Cook & Bassetti, 2005). For example, L1 English speakers with alphabetic literacy must learn a new *writing system* with Arabic, which uses an abjad (Showalter & Hayes-Harb, 2015).

Table 1

Selected Consonantal GPCs from English, French, and German

	Phones				
Graphemes	[t͡ʃ]	[ʃ]	[k(w)]/[k]/[k(ʊ)]	[ç]	[x]/[χ]
English					
<ch>	***ch****ance*	***ch****aperone*	***ch****aos*		*Lo**ch*** (dial.)
<c>	***c****ello*	*licori**c**e*	***c****oin*		
<k>/<kh>			***k****ey* / ***kh****a**k**i*		
<ck>			*thi**ck***		
<q>/<qu>			***q****uiet*		
<sh>		***sh****ip*			
French					
<ch>		***ch****ance* / ***ch****ic*	***ch****aotique*		
<c>			*chi**c***		
<k>			***k****ilo*		
<q>/<qu>			***qu****atre* / *chaoti**qu**e*		
German					
<ch>		***Ch****ampignon*	***Ch****aos*	*e**ch**t*	*a**ch**t*
<g>				*billi**g***	
<k>			*A**k**er*		
<ck>			*E**ck**e*		
<q>/<qu>			***q****uer*		
<sch>/<s>		***sch****eu* / ***S****port*			
<tsch>	***tsch****üss*				

Note. GPCs may vary between dialects; most English dialects lack [x]/[χ]. Lexical frequency also varies between GPCs within a language, and some are rare or limited mainly to loan words.

Alternatively, L2 acquisition may involve the same writing system (e.g., alphabet) but require learning a new *script* (e.g., Roman for English vs. Cyrillic for Russian; Showalter, 2018a). Even within the same script, L1 and L2 use different *orthographies*—that is, language-dependent rules for the use of a script (Cook & Bassetti, 2005, p. 3)—to encode sounds (e.g., L1 English L2 French; Sturm, 2012); this last scenario is common in FL settings, yet less commonly studied in the literature (Bassetti, Vaid, & Cook, 2012). Even sharing a common script, L1 and L2 often differ in how their orthographies encode sounds, so that GPCs—"the mapping between letters and sounds"—are not *congruent* between languages; furthermore, alphabetic orthographies also vary in terms of how *consistent* their GPCs are.

This consistency is understood as "a function of the number of phonemes or graphemes corresponding to one another *within* a language" (Showalter, 2018b, pp. 20–21). English and French both have relatively opaque and *inconsistent* orthographies, but their GPCs are not *congruent* with each other—for example, <ou> does not represent the same set of phonemes in English as in French, nor in the same frequency. Some consonantal examples are shown in Table 1. In contrast to English and French, German GPCs are more transparent and more *consistent*, yet *incongruent* with English or French—for example, in Standard German the digraph <ch> represents a range of phones [ç x χ] that do not exist in North American English or French. In Table 1, the fuller a row or column within a language, the less *consistent* the GPCs. Rows and columns with fewer items indicate a tendency toward 1:1 grapheme-phoneme correspondence, such as with German (Table 1); yet even here atypical words reduce orthographic consistency of [k] (e.g., ***Ch****aos*, ***q****uer*) and phonological consistency of <ch> (***Ch****aos*, ***Ch****ampignon*). German neutralization of consonantal voice in final position (final devoicing; Wiese, 1996, p. 200) adds further complexity. Even sampling a few GPCs shows clear incongruence between languages.

METHOD

Participants

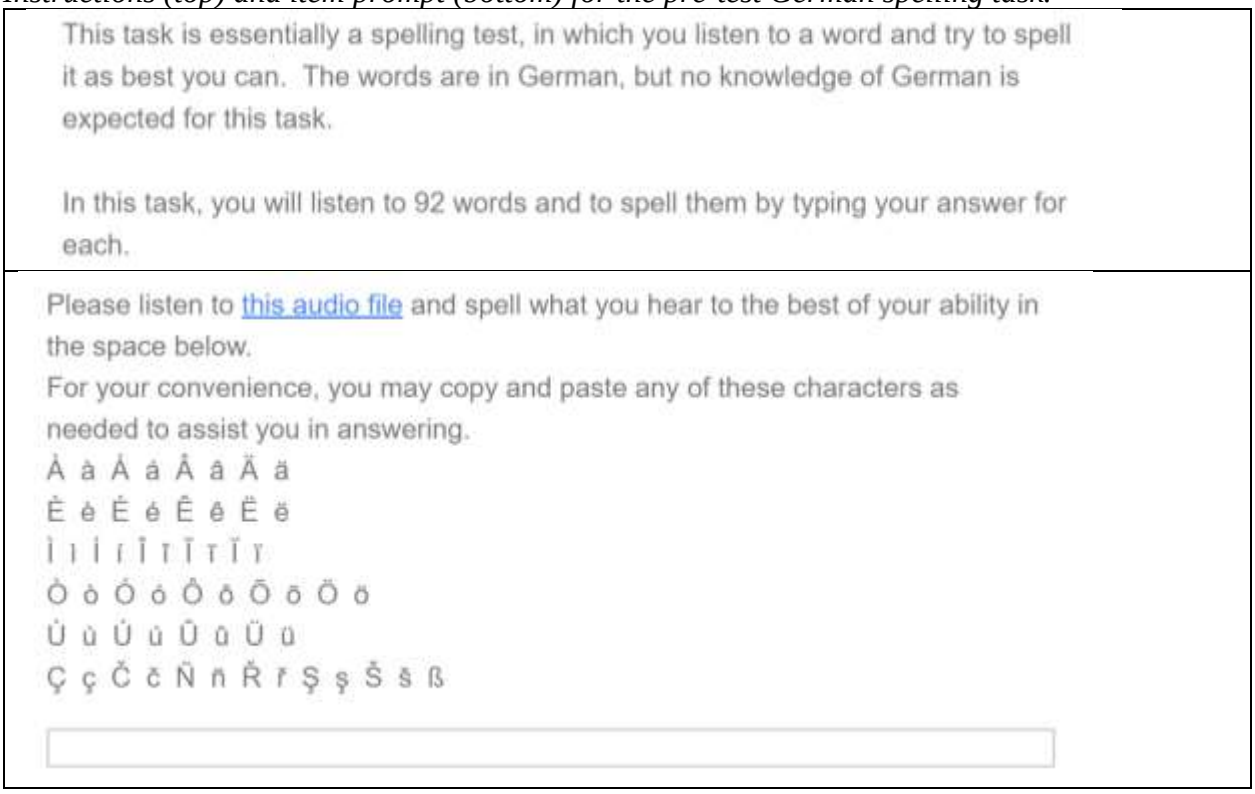
Participants (n = 23) were recruited from a first-semester university German course in Alberta prior to the course's onset. We excluded four participants with L1s other than English; three more were excluded to avoid prior German experience or other any other L2(s) as potential confounds in order to investigate groups that were as linguistically uniform as possible. This left 12 participants with no prior German experience (L2 German: n = 7; L2 French/L3 German: n = 5). Of these, eight completed the entire study (L2 German: n = 4; L2 French/L3 German: n = 4). The first-semester curriculum included one instructional day focused on letters and pronunciation in the second week of the semester, based on 3 pages in the textbook (Gonglewski, Moser, Partsch, Widmaier, & Widmaier, 2019, pp. 9–11). This was the only textbook-supported lesson on consonant pronunciation in the course; each subsequent chapter includes a lesson on pronunciation of certain vowels, diphthongs, or vowel digraphs. Participants did not receive further GPC instruction through the study; however, individual instructors may have focused more or less on pronunciation in lectures or tutorials.

Materials

The study included three online tasks administered using Qualtrics (Version July/August 2020). The first task was an adaptation of the LEAP-Q background questionnaire (Marian, Blumenfeld, & Kaushanskaya, 2007), used to screen participants for the subsequent tasks. The second and third tasks were a German spelling pre-test and post-test; each item included a real German word presented aurally and a prompt asking participants to type what they heard (Figure 1).

Figure 1

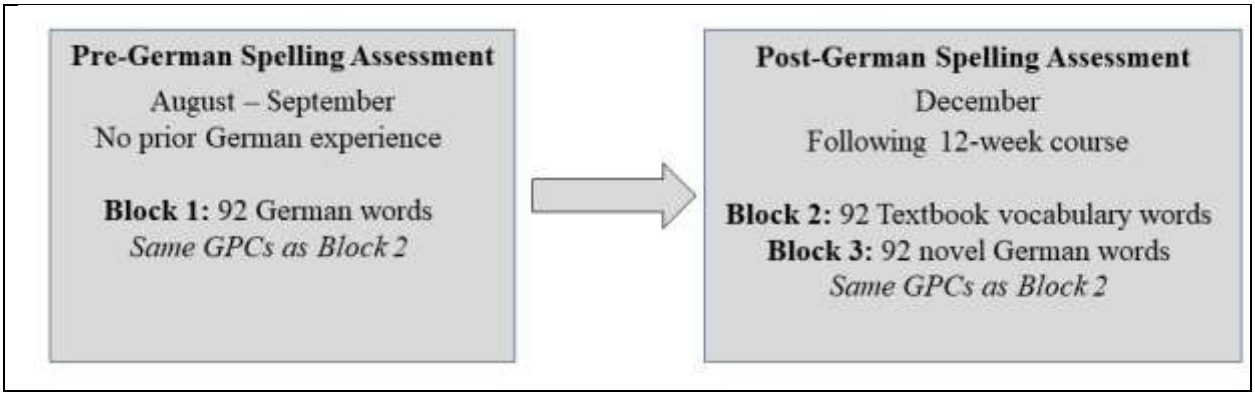
Instructions (top) and item prompt (bottom) for the pre-test German spelling task.



Due to lack of access to recording facilities during the COVID-19 pandemic, audio files for selected German words were downloaded from the Forvo online pronunciation dictionary or from Wiktionary. Where multiple recordings were available, we selected among voices on the basis of audio quality and generally selected female voices over male voices for the sake of higher fundamental frequency (as available; Forvo, n.d.; Wiktionary, n.d.). A total of 66 voices were included in the task. Audio files were standardized to 44.1 kHz sampling rate mono recordings and amplitude was normalized using Adobe Audition (Version 13).

Figure 2

Pre-Test/Post-Test three-block design.



Three item blocks were constructed for a pre-test/post-test design, as shown in Figure 2. The Pre-Test (Block 1) included 92 words that were unfamiliar to participants with no prior German experience. Block 1 words for pre-testing were selected for phonotactic position of the target phone and GPC to match the words in Block 2. For the post-test at the end of the course, Block 2 consisted of words that had been presented in the textbook's vocabulary lists for the chapters covered. To compile this block, we indexed all vocabulary lists from the textbook that were encountered during the course according to whether they contained one of nine consonants of interest [ʃ ç h k ʁ s ts x z] or 10 vowels of interest [aː ɛː øː a eː iː oː ɐ uː yː] following their pronunciation dictionary transcriptions (Duden, 2003; Gonglewski et al., 2019). We selected five words for each consonant and vowel condition from the vocabulary lists for all but one condition, including a variety of phonotactic positions and orthographic representations for each phone (to the extent available in the vocabulary lists). The exception was the [ɛː] condition, spelled <ä>: only two words with this phone were available in the vocabulary lists. The 92 selected words were used to construct Block 2, the Familiar condition of the Post-Test. Similarly to Block 1, 92 additional words featuring the same conditions and balance of phonotactic positions and GPCs were used to construct Block 3, comprised of words that were still unfamiliar after the conclusion of the 12-week course. Thus Block 1 reflected spelling strategies before exposure to German, Block 2 reflected spelling knowledge gained for familiar vocabulary items during the course, and Block 3 reflected spelling strategies applied to novel L2 words that feature L2 sounds encountered during the course, to investigate generalizability of L2 GPC awareness. Each word was used only once in the course of the study. To focus on key patterns in our results, we report only [ʃ ç ʁ s ts x z] and [ɐ] (vocalized allophone of [ʁ]) conditions here.

Procedure

Participants completed all tasks online in a setting of their choice. The language background questionnaire (20 min) and spelling pre-test (30 min) were administered prior to the start of classes for the semester; participants received an electronic gift card for CAD $10 for each. The spelling post-test (60 min) was administered after the end of the 12-week semester; participants received electronic gift cards totalling CAD $20 for the post-test. Items in the pre-test and post-test were randomized within blocks. Both spelling tasks were self-paced.

RESULTS

Data Coding

Responses to the spelling tasks were coded according to the following criteria:

- What letter(s) was/were used to represent the target sound? (string)
- Was the target sound within the word spelled **correctly** according to German orthography? (binary)
- For each language (German, English, French; binary):
  - Was the spelling a possible way to spell the **target sound** in [language]?
    - e.g., *Sti**ch***: <ch>-[ç], but <g> was given (cf. *willig*) = 1 (German)
  - Was the spelling a possible way to spell an ***adjacent* sound** in [language]?
    - e.g., *Sti**ch:*** <ch>-[ç], but <sh> was given (cf. *ma**sh***) = 1 (English)
  - Does it appear that they responded with a ***different* word** in [language]?
    - e.g., ***f**romm*: <r>-[ʀ], but <from> was given = 1 (English)

This present report focuses on the coding of targetlike spelling and alternate possible spellings for German orthography only. The notion of an *adjacent* phone is an exploratory measure, reckoned as a phone that differed from the stimulus phone by a single feature (e.g., adjacent place of articulation, such as alveolopalatal vs. palatal, or a single manner feature, such as stop vs. fricative). For Block 2, where there might be ambiguity between misspelling of a familiar German word and identification as a *different* word from English, only nine words were marked as identifying an English word (e.g., German *nervös*, *Monat* transcribed <nervous>, <Walnut>, respectively). Of these, only one response to German *dich*, transcribed as <Dish>, appeared to permit interpretation as a misspelled German target word due to confusion of [ç] with [ʃ].

Due to these binary variable structures (0 vs. 1) and small sample size (n = 4 per group), any statistical model of these data would be susceptible to Type I error. Additionally, power analysis shows that a larger sample would be required to make clear claims about even a strong effect size (e.g., for $d = 0.80$, $n \geq 35$). For this reason, we report no inferential statistics here.

Global Patterns

The global results in aggregate show that beginning FL German learners (a) measurably improve in their knowledge of German GPCs over the course their first semester, and (b) can generalize this GPC knowledge somewhat to novel German words even at the first aural exposure to the new word (Table 2). The proportion of target-accurate spellings increases from .38 at pre-test to .75 at post-test with words encountered in the vocabulary lists. Furthermore, after the first semester, even novel German words (Block 3, .58) show improved use of the same GPCs over pre-test. The more tolerant measure of using some possible GPC for the target sound (e.g., <f> for an English word where <ph> was required) shows the same pattern across blocks with higher proportions, indicating that learners perceive alternative GPCs in the target language as well. In contrast to the trend toward improved knowledge of German GPCs, proportions for invented spellings for the target sounds in German words based on English or French GPCs (Table 3, Possible for Target) remain essentially flat over time; even use of English or GPCs that represent phonetically adjacent sounds (Table 3, Possible for Adjacent) rises only slightly over time.

Table 2

Global Proportions of Spelling Accuracy and Approximation (German)

	Mean (*SD*)		
	Pre-German	Post-German	
German Spelling	Block 1	Block 2	Block 3
Correct for Target	**.38 (.485)**	**.75 (.435)**	**.58 (.494)**
Possible for Target	.51 (.500)	.78 (.415)	.65 (.477)
Possible for Adjacent	.19 (.390)	.24 (.426)	.33 (.472)
Different German Word	.07 (.260)	.12 (.320)	.16 (.371)

In addition, it seems that spurious activation of English or French words (e.g., German *Reiz* [ʀaits] 'charm, appeal' interpreted as English *rights* or *writes*) is rare in these learners. Overall, participants' responses are more in line with English GPCs than with French GPCs, which is unsurprising, since approximately half of the data come from the L1 English L2 German group with no L2 French experience. Unlike English or French GPC use, German GPC use increases over time, and learners can generalize their German GPC knowledge somewhat to novel German words.

Table 3

Global Proportions of Spelling Accuracy and Approximation (English, French)

	Mean (*SD*)		
	Pre-German	Post-German	
Spelling	Block 1	Block 2	Block 3
German			
Correct for Target	**.38 (.485)**	**.75 (.435)**	**.58 (.494)**
English			
Possible for Target	.50 (.500)	.48 (.500)	.47 (.500)
Possible for Adjacent	.56 (.497)	.62 (.485)	.61 (.488)
Different (English) Word	.06 (.246)	.01 (.110)	.04 (.192)
French			
Possible for Target	.41 (.491)	.37 (.484)	.37 (.483)
Possible for Adjacent	.30 (.457)	.32 (.466)	.35 (.478)
Different (French) Word	.01 (.111)	.00 (.052)	.01 (.082)

Familiar Sounds

Learner performance with the L1-familiar sounds [ʃ s z] associated with different GPCs in the target language sheds light on the orthographic side of GPC learning. Table 4 presents aggregate data for the [ʃ] consonantal condition. This phone is most commonly represented in German either by <sch>, as in *Schrank* [ʃʁaŋk] 'cupboard,' or by <s>, as in *Stunde* [ˈʃtʊn.də] 'hour.' With familiar vocabulary (Block 2), both L2 German and L2 French/L3 German groups exhibit high accuracy with target GPCs. The L2 French group's lower performance in Block 3 is the result of overgeneralization of <sch> in words that require <s>, as compared to the group with no French experience.

Table 4

Proportions of Spelling Accuracy and Approximation (German): [ʃ]

	Mean (*SD*)					
	Pre-German		Post-German			
	Block 1		Block 2		Block 3	
German Spelling	No Fr	L2 Fr	No Fr	L2 Fr	No Fr	L2 Fr
Correct for Target	.43 (.502)	.44 (.507)	.90 (.308)	.90 (.308)	.90 (.308)	.65 (.489)
Possible for Target	.97 (.180)	.76 (.436)	1.00 (.000)	.95 (.224)	1.00 (.000)	1.00 (.000)
Possible for Adjacent	.03 (.180)	.16 (.374)	.00 (.000)	.05 (.224)	.15 (.366)	.00 (.000)

Note. No Fr = L1 English L2 German; L2 fr = L1 English, L2 French L3 German.

In German, [s] may be represented by <s>, as in *Gas* [gaːs] 'gas,' by <ss>, as in *essen* [ˈɛs.sən] 'to eat,' or by <ß>, as in *bloß* [bloːs] 'merely.' Understandably, pre-learners (Block 1) have no knowledge of the unique German letter <ß> ('ess-tsett'). With familiar vocabulary (Table 5, Block 2), both language background groups exhibit high accuracy spelling [s] in German; however, learners show non-targetlike use of <c> and <sc> to represent [s], and in coda clusters, these learners sometimes use <z> to represent [s].

The letter <z> poses an interference problem for L1 English learners of German, to whom it represents voiced [z], whereas in German [z] can only be represented by <s>, in certain environments (e.g., *See* (m.) [zeː] 'lake,' *lesen* [ˈleː.zən] 'to read').

Table 5

Proportions of Spelling Accuracy and Approximation (German): [s]

	Mean (*SD*)					
	Pre-German		Post-German			
	Block 1		Block 2		Block 3	
German Spelling	No Fr	L2 Fr	No Fr	L2 Fr	No Fr	L2 Fr
Correct for Target	.51 (.507)	.60 (.500)	.90 (.308)	.95 (.224)	.75 (.444)	.65 (.489)
Possible for Target	.93 (.254)	.92 (.277)	1.00 (.000)	1.00 (.000)	.85 (.366)	.80 (.410)
Possible for Adjacent	.00 (.000)	.04 (.200)	.70 (.470)	.60 (.503)	.40 (.503)	.50 (.513)

Table 6

Proportions of Spelling Accuracy and Approximation (German): [z]

	Mean (*SD*)					
	Pre-German		Post-German			
	Block 1		Block 2		Block 3	
German Spelling	No Fr	L2 Fr	No Fr	L2 Fr	No Fr	L2 Fr
Correct for Target	.40 (.407)	.28 (.458)	.90 (.308)	.85 (.366)	.75 (.444)	.80 (.410)
Possible for Target	.42 (.502)	.28 (.458)	.90 (.308)	.85 (.366)	.75 (.444)	.80 (.410)
Possible for Adjacent	.03 (.174)	.04 (.200)	.95 (.224)	.85 (.366)	.75 (.444)	.80 (.410)

Following the English GPC of <z>-[z], these learners tend to represent [z] in initial or medial positions as <z> rather than <s> as German requires. After initial exposure, learners sometimes spuriously identify the voiceless German <ß> with the voiced [z] sound, which complicates their GPC awareness.

Some German vowel GPCs pose a particular problem for L1 English learners of German due to the deviant qualities and names of the vowels in English as compared to the German, which more closely adhere to typical Latin vowel values for the Roman alphabet (i.e., <a>-[a], <e>-[e], etc.). L1 English learners tend to identify German [aː] with <au> (cf. English *taunt*) and German [eː]

with <a>, per their English names. The German notation of <eh> for [eː], in which <h> is a vowel length marker, is unfamiliar to pre-learners before German exposure. Finally, despite the existence of analogous vowels [iː] and [eɪ] in English, the language-specific perceptual boundary between German [iː] and [eː] challenges pre-learners and early learners (this turns out to be a consistent problem for perception of German high and mid vowels by L1 English speakers generally).

Novel Sounds

For perception of novel German phones by pre-learners and learners, no GPC congruence between languages is possible. For example, pre-learners produce a wide variety of invented spellings for [x] (e.g., <gh>, <f>, <h>) in addition to the target <ch> (Table 7). Even after exposure, only one participant generalized [ɛː] from *Käse* (Block 2) to novel *Däne* (Block 3).

Table 7

Proportions of Spelling Accuracy and Approximation (German): [x]

	Mean (*SD*)					
	Pre-German		Post-German			
	Block 1		Block 2		Block 3	
German Spelling	No Fr	L2 Fr	No Fr	L2 Fr	No Fr	L2 Fr
Correct for Target	.43 (.502)	.12 (.332)	.90 (.308)	.65 (.489)	.90 (.308)	.65 (.489)
Possible for Target	.45 (.506)	.12 (.332)	.90 (.308)	.65 (.489)	.85 (.366)	.60 (.503)
Possible for Adjacent	.24 (.435)	.32 (.476)	.05 (.224)	.20 (.410)	.85 (.366)	.75 (.444)

The L2 French group often identified [x] as <r> (cf. French [ʁ]) or as no grapheme at all (presumably a failure to perceive the fricative) and continued identifying it as <r>, even with familiar words (Block 2) at post-test. Pre-learners of both groups identified German [ç] poorly (Table 8), especially the L2 French group (.12), who showed much less improvement with <ch> in Block 2. In unfamiliar words, both groups tended to label this sound <sch>, suggesting a perceptual difficulty in opposition to the familiar [ʃ] category.With perception of the German rhotic [ʁ], pre-learners with L2 French experience show an early advantage of those without (Table 9; .76 over .57). Perception is less robust in medial position, e.g., *getreu*.

Table 8

Proportions of Spelling Accuracy and Approximation (German): [ç]

	Mean (*SD*)					
	Pre-German		Post-German			
	Block 1		Block 2		Block 3	
German Spelling	No Fr	L2 Fr	No Fr	L2 Fr	No Fr	L2 Fr
Correct for Target	.29 (.458)	.12 (.332)	.80 (.410)	.60 (.503)	.35 (.489)	.30 (.470)
Possible for Target	.38 (.492)	.17 (.381)	.80 (.410)	.65 (.489)	.35 (.489)	.45 (.510)
Possible for Adjacent	.47 (.507)	.46 (.509)	.15 (.366)	.25 (.444)	.55 (.510)	.50 (.513)

Table 9

Proportions of Spelling Accuracy and Approximation (German): [ʁ]

	Mean (*SD*)					
	Pre-German		Post-German			
	Block 1		Block 2		Block 3	
German Spelling	No Fr	L2 Fr	No Fr	L2 Fr	No Fr	L2 Fr
Correct for Target	.57 (.502)	.76 (.436)	.90 (.308)	.90 (.308)	1.00 (.000)	.85 (.366)
Possible for Target	.61 (.496)	.76 (.436)	.90 (.308)	.90 (.308)	1.00 (.000)	.85 (.366)
Possible for Adjacent	.03 (.174)	.00 (.000)	.00 (.000)	.05 (.224)	.00 (.000)	.00 (.000)

Pre-learners fail to perceive vocalized German rhotic [ɐ] (Table 10) reliably. This is only partly overcome by exposure and may depend on formant transitions. Learners rarely perceive German [t͡s] (Table 11) medially or in onsets, and the <z>-[t͡s] GPC sees perceptual confusion with [st] and orthographic confusion with the <tz>-[t͡s] GPC.

Table 10

Proportions of Spelling Accuracy and Approximation (German): [ɐ]

	Mean (*SD*)					
	Pre-German		Post-German			
	Block 1		Block 2		Block 3	
German Spelling	No Fr	L2 Fr	No Fr	L2 Fr	No Fr	L2 Fr
Correct for Target	.29 (.458)	.24 (.436)	.70 (.470)	.70 (.470)	.60 (.503)	.55 (.510)
Possible for Target	.29 (.467)	.32 (.476)	.70 (.470)	.70 (.470)	.60 (.503)	.55 (.510)
Possible for Adjacent	.26 (.448)	.16 (.374)	.10 (.308)	.10 (.308)	.15 (.366)	.05 (.224)

Table 11

Proportions of Spelling Accuracy and Approximation (German): [t͡s]

	Mean (*SD*)					
	Pre-German		Post-German			
	Block 1		Block 2		Block 3	
German Spelling	No Fr	L2 Fr	No Fr	L2 Fr	No Fr	L2 Fr
Correct for Target	.11 (.323)	.04 (.200)	.85 (.366)	.80 (.410)	.35 (.489)	.20 (.410)
Possible for Target	.58 (.502)	.52 (.510)	.85 (.366)	.85 (.366)	.80 (.410)	.55 (.510)
Possible for Adjacent	.30 (.467)	.28 (.458)	.15 (.366)	.10 (.308)	.20 (.410)	.45 (.510)

DISCUSSION

In FL learning contexts where category perception and association to alphabetic GPCs develop simultaneously rather than in sequence, sequences of exposure to novel sounds and the GPCs used to encode them in writing in the target language must be considered as a factor in early L2 phonological development. For example, our index of the textbook vocabulary lists revealed extremely few words that featured the German <ö>-[øː]/[œ] GPC, a problem for establishing new perceptual categories to differentiate front rounded vowels from their back counterparts. Initial exposure to the alphabet and German orthography at the start of the course included only four

example words for the <ö> grapheme, two each for short and long durations. After that, the novel front rounded vowels are not the focus of a lesson until about 9 weeks later. In addition, differences in the boundary between high and mid vowels in German as compared to English provide an acoustic challenge for new GPCs, while incongruent vowel GPCs between English and French vs. German (e.g., French <u>-[yː], <ou>-[uː] vs. German <u>-[uː]) set learners up for widespread orthographic interference in L2/L3 German. Thus, adult L2 learners are posed with a double challenge: novel categories and category boundaries in the target language, and learning to associate them with a novel set of GPCs; for L3 learners, the categories and GPCs of any prior L2(s) also play a role that can help or hinder according to the category and GPC in question.

These results highlight potentially complex relationships between phonological perception and orthography in the formation of new GPCs in L2/L3 acquisition. Early learners learn new GPCs with new vocabulary, including some capacity for generalization to new vocabulary. However, acquisition of L2/L3 GPCs is not straightforward; numerous perceptual and orthographic factors can aid learning some GPCs yet hinder others. In general, consonant GPCs are more congruent between English, French, and German than vowel GPCs, suggesting differential attention may be required in FL settings. Common L1 English background yields broadly similar performance, but L2 French experience (phonological and orthographic) can exert its own influences on acquisition of specific GPCs in L3 German. In adult FL contexts, more explicit instruction with certain target language GPCs and vocabulary choices that keep GPCs in mind may be warranted. Acquisition of new GPCs by adult FL learners depends both on their perception and their literacies, with implications for vocabulary, listening comprehension, etc. Given the variety of L1-L2/L3 learner profiles in adult FL contexts, additional research is needed to understand the influences of inter-language incongruence and intra-language inconsistency of GPCs on phonological acquisition.

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