Supporting Information for: Murakami, A., & Ellis, N. C. Effects of availability, contingency, and formulaicity on the accuracy of English grammatical morphemes in second language writing. Article accepted in *Language Learning* on 22 January 2022.

Appendix S1: Details and Accuracy Evaluation of Data Retrieval

Irregular Verbs and Nouns

In the identification of irregular verbs, we first retrieved the word forms tagged as a past-tense verb in the Corpus of Contemporary American English (COCA; Davies, 2008-) and examined whether each of them was a regular or irregular verb by applying a simple set of conversion rules (e.g., deleting word final -*ed*) and analyzing whether they turned the inflected form into the corresponding base form. For each of the irregular verbs identified, we then counted its frequency in the COCA. The exploration of the resulting list suggested that lower frequency items included erroneously identified forms where the identification errors were caused, for instance, by tagging errors. We thus only retained the words that occur 100 or more times in the COCA, which led to a list of 231 candidate words for irregular verbs. We then manually inspected the list and deleted inappropriate items (e.g., past participle or base form erroneously identified as a past-tense form). The procedure led to the following list of 205 irregular past tense verb forms. Their lemmas, past-participle forms, and third-person singular forms were also used to exclude irregular verbs in the identification of errors and accurate uses of past tense -*ed* (explained below).

arose, ate, awoke, bade, beat, became, befell, began, beheld, bent, beset, bet, bid, bit, bled, blew, bought, bound, breastfed, bred, broke, brought, built, burnt, burst, came, cast, caught, chose, clung, cost, crept, cut, dealt, did, dove, drank, dreamt, drew, drove, dug, dwelt, fed, fell, felt, fled, flew, flung, forbade, foresaw, foretold, forgave, forgot, fought, found, froze, gave, got, grew, ground, had, heard, held, hid, hit, hove, hung, hurt, kept, knelt, knew, knit, laid, lay, leant, leapt, learnt, led, left, lent, let, lit, lost, made, meant, met, mimicked, misled, misread, mistook, misunderstood, offset, outdid, outran, overcame, overdid, overheard, *overpaid, overran, overrode, overshot, overthrew, overtook, paid, panicked, partook, pled, put, quit, ran, rang, read, rebuilt, recast, remade, repaid, reread, resold, retold, retook, rid, rode, rose, said, sang, sank, sat, saw, sent, set, shone, shook, shot, shrank, shut, slept, slid, slit, slung, slunk, smelt, smote, snuck, sold, sought, spat, sped, spelt, spent, split, spoke, sprang, spread, sprung, spun, stank, stole, stood, strode, strove, struck, stuck, stung, swam, swept, swore, swung, taught, telecast, thought, threw, thrust, told, took, tore, trafficked, trod, undercut, underlay, underpaid, understood, undertook, underwent, underwrote, undid, unsaid, unwound, upset, was, went, wept, were, withdrew, withheld, withstood, woke, won, wore, wound, wove, wrote, wrung*

We followed a similar procedure in the identification of irregular plural noun forms. Due to the generally higher frequency of nouns, however, we used the threshold of 200 occurrences in the COCA instead of 100 occurrences. Also, we included plural forms ending in -*men* regardless of their frequency because they follow a systematic pattern (e.g., *saleswoman* → *saleswomen*). This led to the following list of 313 irregular plural noun forms.

aioli, airmen, airwomen, aldermen, alumni, analyses, anchormen, antennae, appendices, artillerymen, assemblymen, axemen, axes, backwoodsmen, badmen, bagmen, basemen, batmen, batsmen, bellmen, birdmen, biscotti, bluesmen, boatmen, bogeymen, bogymen, bondsmen, bookshelves, bowmen, brakemen, brethren, bushmen, businessmen, businesswomen, busmen, cacti, calamari, calves, cameramen, cannoli, cattlemen, catwomen, cavalrymen, cavemen, chairmen, chairwomen, chapmen, charwomen, cherubim, children, cholerae, churchmen, churchwomen, clansmen, clergymen, coachmen, committeemen, congressmen, consortia, councilmen, countrymen, cracksmen, craftsmen, craftswomen, crewmen, crises, criteria, crossbowmen, curricula, dairymen, deadmen, defensemen, diagnoses, dicta, doormen, draftsmen, draughtsmen, draymen, dustmen, dwarves, elves, *emphases, englishmen, erotica, feet, fieldsmen, firemen, fishermen, fisherwomen, fishmen, foci, footmen, foremen, formulae, frenchmen, freshmen, frogmen, frontiersmen, frontmen, fungi, funnymen, gasses, geese, genera, gentlemen, gentlewomen, gnocchi, grandchildren, groomsmen, groundsmen, guardsmen, gunmen, halves, hangmen, harvestmen, headmen, helmsmen, henchmen, herdsmen, highwaymen, hitmen, hooves, horsemen, horsewomen, housemen, housewives, huntsmen, husbandmen, hypotheses, icemen, indices, indies, infantrymen, influenzae, irishmen, journeymen, jurymen, kinsmen, kinswomen, knives, labia, laddermen, landsmen, larvae, laundrymen, lawmen, laymen, laywomen, leaves, lensmen, lice, liegemen, linemen, literati, liverymen, lives, loaves, lobstermen, longbowmen, longshoremen, lumbermen, madwomen, mailmen, manxmen, marksmen, markswomen, matrices, maxima, memorabilia, memoranda, men, merchantmen, mermen, metastases, mice, middlemen, midshipmen, midwives, militiamen, millennia, minima, miniseries, minutemen, minutiae, moneymen, mortarmen, musclemen, nebulae, needlewomen, neuroses, newsmen, newspapermen, nightwatchmen, noblemen, norsemen, nuclei, nurserymen, oarsmen, oases, ombudsmen, outdoorsmen, oxen, oystermen, packmen, paparazzi, parentheses, patrolmen, personae, phenomena, pitchmen, pitmen, placemen, plainclothesmen, plantsmen, pneumoniae, police, policemen, policewomen, porcini, postmen, pressmen, prostheses, pylori, quarrymen, quizzes, radii, raftsmen, railwaymen, referenda, regalia, renminbi, repairmen, riflemen, rivermen, roadmen, roundsmen, salarymen, salesmen, saleswomen, scarves, schemata, schoolchildren, seamen, selectmen, selves, sequelae, servicemen, servicewomen, sheaves, shelves, shopmen, sidemen, snowmen, spacemen, spearmen, spectra, spokesmen, spokeswomen, sportfishermen, sportsmen, sportswomen, statesmen, steelmen, stickmen, stigmata, stimuli, stockmen, strata, strawmen, strongmen, stuntmen, supermen, supernovae, superwomen, swordsmen, syllabi, tableaux, tacksmen, taxmen, teeth, theses, thieves, townsfolk, townsmen, tradesmen, treemen, trenchermen, tribesmen, tumours, underclassmen,* *upperclassmen, vertebrae, vertices, vestrymen, vitae, washermen, washerwomen, watchmen, watermen, weathermen, werewolves, wildmen, wingmen, wives, wolves, women, woodmen, woodsmen, workmen, yachtsmen, yardmen*

Identification of Errors and Accurate Uses

Past Tense *-ed*. In the identification of the errors of past tense -*ed*, the following conditions had to be met:

1. The original and corrected forms shared the same base form;
2. The verb was not among the irregular verbs identified above;
3. The original form was a base form or the form inflected with third person -*s*;
4. The part of speech of the inflected form was VBD (past tense verb) or unidentified due usually to the difficulty in identifying the corresponding corrected form, which in turn was often caused by tokenization errors;
5. Either the error tag is VT (verb tense) or the part of speech of the original form was a verb or unidentified;
6. The words *be*, *have*, or their inflected forms did not occur within the three preceding words from the target inflected form in the teacher-corrected writing;
7. The word *to* did not occur in the preceding context of the target word in the original writing; and
8. The preceding context of the target word in the original writing did not include past tense modal verbs (i.e., *could*, *might*, *should*, *would*).

Condition 6 was necessary to exclude errors pertaining to the use of -*ed* as past participle forming passive voice or perfect aspect. Condition 7 excluded the cases where *to*-infinitives were corrected into past tense forms (e.g., *to talk* corrected into *talked*). These cases should be excluded due to the change in finiteness. Condition 8 excluded errors with modal verbs (e.g., *could start* corrected into *started*).

A similar set of conditions was used in the identification of accurate uses. Of particular note is the fact that Conditions 6 through 8 were also applied to the identification of accurate uses. If, for instance, *to* occurred within three preceding words from the target word, it was not counted as an accurate use. This meant that the occurrence of *worked* in the following sentence, for example, was not counted as an accurate use of past tense *-ed*: *The software was easy to use and* ***worked*** *on OS X*. The condition was necessary because, due to the corresponding condition in error identification, the instance where the sentence *The software is easy* ***to*** *use and* ***works*** *on OS X* was corrected into *The software was easy to use and* ***worked*** *on OS X* was erroneously excluded from the error counts of past tense *-ed*. This erroneous exclusion itself was a trade-off with the intended exclusion of the errors pertaining to *to*-infinitives, as we mentioned earlier. What it entailed, however, was that there was no opportunity for learners' errors to be counted as those of past tense *-ed* in the given sentence, and thus the occurrence of *worked* there should not be counted as an accurate use because otherwise the accuracy would be potentially unfairly inflated. Importantly, we applied all the conditions except for Conditions 4 and 5 in the construction of gold standards (i.e., manually identified errors and accurate uses against which we checked the accuracy of the algorithm to count them) as well.

Progressive *-ing*. Similar to past tense *-ed*, the following conditions had to be satisfied in the identification of the errors of progressive *-ing*:

1. The original and corrected forms shared the same base form;
2. The part of speech of the inflected form was VBG (*-ing* form of a verb) or unidentified;
3. A *be* verb occured within three words preceding the target inflected word;
4. Either the inflected word was not *going* or it was not immediately followed by *to*;

5. Either the preceding context (i.e., three words before the target word) in the original writing did not include a *be* verb or the part of speech of the uninflected form was neither VBD (past tense form) or VBN (past participle);
6. The preceding context of the inflected form in the corrected writing did not include a preposition; and
7. The preceding context in the original writing did not include *to*.

Condition 4 excluded *be going to*, while Condition 5 excluded voice errors (e.g., *is directed* corrected into *is directing*). Condition 6 excluded such expressions as *be capable of speaking*, and Condition 7 excluded cases involving *to*-infinitives (e.g., *was great to see you* corrected into *was great seeing you*). As in past tense -*ed*, these conditions were applied in the identification of accurate uses as well. Consequently, expressions such as *to be joining* were not counted as the instances of progressive -*ing*.

Third Person -*s*. The following conditions had to be met in the identification of third person -*s* errors:

1. The original and corrected forms shared the same base form;
2. The lemma of the verb was not *be*, *have*, or *do*;
3. The part of speech of the inflected form was VBZ (third person verb form);
4. The part of speech of the original form was not VBD (past tense form), VBN (past participle), or VBG (-*ing* form);
5. The preceding context of the original form did not include a *be* verb, *to*, modal verbs, or causative verbs (i.e., *let*, *make*, *have*).

Condition 4 excluded tense errors (e.g., *liked* corrected into *likes*) and aspect errors (e.g., *is acting* corrected into *acts*). Condition 5 excluded the errors involving the overuse of *be* verbs (e.g., *that's depend* corrected into *that depends*) and change in finiteness (e.g., *to begin* corrected into *begins*, *can go* corrected into *goes*, *makes it go* corrected into *goes*). As in the other morphemes, we applied a similar set of conditions in the identification of the accurate uses of third person -*s* as well.

Plural -*s*. In the identification of the errors of plural -*s*, (a) the original and corrected forms had to share the same base form, and (b) both the original form and the corrected form had to be tagged as singular or plural nouns (NN, NP, NNS, or NPS), or the part of speech was unidentified. In the identification of accurate uses, the part of speech of the inflected form had to be NNS (plural common noun), NPS (plural proper noun), or unidentified.

Evaluation of Retrieval Accuracy

We estimated the accuracy of the identification of the errors and accurate uses by manually examining a subset of the data. Specifically, we randomized all the writings and, for each morpheme, manually identified 100 learner errors and 100 accurate uses. We then compared the results to the instances identified by the R script and calculated precision, recall and F_1 score. Table S1.1 shows the retrieval accuracy for each morpheme. The accuracy was fairly high in all the cases, with all the F_1 scores exceeding .85. The results based on the R script, therefore, should be reasonably credible.

Table S1.1 Precision, recall, and F_1 score of the R script used to identify the errors and accurate uses of each morpheme

Error/Accurate use	Precision	Recall	F_1
Past tense *-ed*			
Error	0.93	0.85	0.89
Accurate use	0.93	0.91	0.92
Progressive *-ing*			
Error	0.85	0.90	0.87
Accurate use	0.84	0.89	0.86
Third person *-s*			
Error	0.93	0.85	0.89
Accurate use	0.94	0.96	0.95
Plural *-s*			
Error	0.99	0.88	0.93
Accurate use	0.98	0.98	0.98

Note. Precision refers to the extent to which what the script captures actually includes what it is intended to capture, while recall refers to the extent to which what is supposed to be captured is actually captured by the script. For example, suppose that a script to count the frequency of past tense *-ed* errors identified 80 instances in a group of writings, and 70 of them correctly included target errors. Let us further suppose that those writings actually included 100 past tense *-ed* errors, precision in this case is 87.5% (70/80) and recall is 70% (70/100). The F_1 score is the harmonic mean of precision and recall and is calculated by the following equation:

$$F_1 = \frac{2}{\frac{1}{precision} + \frac{1}{recall}} = 2 \times \frac{precision \times recall}{precision + recall}$$

List of Target Words

Past tense *-ed*:

accepted, agreed, allowed, answered, appreciated, arrived, asked, attended, belonged, called, changed, checked, closed, created, decided, described, developed, died, discovered, earned, ended, enjoyed, entered, explained, finished, followed, forced, founded, gathered, graduated, happened, hated, helped, included, increased, installed, invited, joined, liked, listened, lived, looked, loved, managed, mentioned, missed, moved, named, needed, offered, opened, ordered, painted, participated, passed, planned, played, preferred, prepared, presented, promised, reached, realized, received, remembered, reported, , requested, responded, selected, served, showed, signed, started, stayed, stopped, stressed, studied, suggested, talked, traveled, tried, used, visited, walked, wanted, watched, worked

Progressive *-ing*:

asking, attending, awaiting, becoming, beginning, being, building, buying, causing, celebrating, changing, checking, coming, counting, dancing, decreasing, developing, doing, drinking, driving, eating, enjoying, expecting, facing, falling, feeling, finding, following, getting, giving, going, growing, happening, having, helping, improving, increasing, inviting, keeping, learning, leaving, listening, living, looking, losing, making, meeting, missing, moving, offering, paying, planning, playing, preparing, producing, putting, raining, reading, rising, running, saving, saying, searching, seeing, seeking, selling, sending, shining, showing, sitting, sleeping, speaking, spending, standing, starting, staying, struggling, studying, taking, talking, teaching, telling, thinking, traveling, trying, turning, using, visiting, waiting, walking, watching, wearing, working, writing

Third person *-s*:

affects, allows, appears, arrives, asks, attracts, becomes, begins, belongs, brings, buys, calls, cares, causes, changes, closes, combines, comes, consists, contains, continues, costs, covers, *creates, depends, deserves, develops, drives, encourages, ends, enjoys, exists, faces, fails, falls, features, feels, fits, follows, gets, gives, goes, grows, happens, helps, holds, hopes, hurts, improves, includes, increases, invites, keeps, kisses, knows, lasts, leads, learns, leaves, lets, lies, likes, listens, lives, looks, loves, makes, manages, matches, means, meets, needs, occurs, offers, opens, owns, passes, pays, plays, prefers, prepares, presents, produces, promotes, provides, puts, reaches, receives, remains, remembers, represents, requires, runs, saves, says, seems, sells, serves, shows, sings, sounds, speaks, spends, stands, starts, stays, stops, studies, suits, supports, takes, teaches, tells, thinks, tries, turns, understands, uses, varies, visits, wakes, wants, wins, works*

Plural -*s*:

activities, animals, areas, books, buildings, cards, cars, cases, cities, classes, clients, clothes, colleagues, colors, companies, computers, costs, countries, customers, days, documents, dollars, drinks, employees, events, eyes, families, friends, games, goods, holidays, hours, houses, ideas, items, jobs, kids, kinds, languages, lessons, lots, machines, markets, meetings, members, minutes, months, movies, neighbors, offices, options, parents, parties, parts, persons, photos, pictures, places, prices, problems, products, projects, resources, restaurants, rooms, sales, schools, services, shoes, shops, sports, states, stores, stories, streets, students, studies, systems, taxes, teachers, things, times, tourists, trees, types, vegetables, weeks, windows, years

Reference

Davies, M. (2008-). The Corpus of Contemporary American English (COCA). Retrieved from https://www.english-corpora.org/coca/

Appendix S2: Calculation of ΔP

Below, we demonstrate how ΔP can be calculated in the phrase *what happened yesterday*, with *happened* as the target word. In the phrase, the cue is *what* ____ *yesterday*, where ____ can be filled in by any word. In the contingency table in Table S2.1, Cell a includes the frequency of the target word (i.e., outcome) given the target context (i.e., cue). In the example above, it corresponds to the frequency of the trigram, *what happened yesterday*, which occurs 318 times in the Corpus of Contemporary American English (COCA; Davies, 2008-). Cell b includes the frequency of the target context (i.e., *what* ____ *yesterday*) where the gap is filled by any word besides the target inflected word (i.e., *happened*). This pattern occurs 62 times in the COCA. Cell c corresponds to the frequency of the target inflected word in any context besides the target context. The COCA includes 162,971 trigram tokens where the second position is filled by *happened* but that are not *what happened yesterday*. Finally, Cell d includes the total frequency of all the trigrams that are not counted in any of the other cells. There are approximately 764 million such trigrams in the COCA. As stated in the main text, ΔP is calculated by [p(outcome | cue)] – [p(outcome | ¬ cue)]. In our case, [p(outcome | cue)] was calculated by $\frac{a}{a+b}$, while [p(outcome | ¬ cue)] was calculated by $\frac{c}{c+d}$. Therefore, ΔP in this particular example is:

$$\Delta P = \frac{a}{a+b} - \frac{c}{c+d} = \frac{318}{318+62} - \frac{162971}{162971+763861708} = 0.8368 - 0.0002 = 0.8366.$$

The observed ΔP value (0.8366) indicates that the context *what* ____ *yesterday* is highly predictive of the word *happened*. When Cells a and c were both 0, which occurred due, for instance, to tokenization errors, we did not compute ΔP in our study because there was no information that allowed us to reliably calculate the value.

Table S2.1 Example contingency table

Cue presence	Outcome = present (i.e., target word)	Outcome = absent (i.e., non-target word)
Cue = present (i.e., target context)	a (318)	b (62)
Cue = absent (i.e., non-target context)	c (162,971)	d (763,861,708)

Reference

Davies, M. (2008-). The Corpus of Contemporary American English (COCA). Retrieved from https://www.english-corpora.org/coca/

Appendix S3: Model Validation

Prior Predictive Checks

The purpose of prior predictive checks is to examine the adequacy of the specification of priors. The idea is that researchers generate hypothetical data based on their priors and examine whether the resulting data are consistent with the expectation based on their domain knowledge (Schad, Betancourt, & Vasishth, 2021). Specifically, we repeated the following procedure 10,000 times:

1. We randomly drew a set of parameter values from the prior distributions described in the main text.
2. Those values, together with the predictor values in our data set and the statistical model structure used in our analysis, were used to simulate hypothetical values of the dependent variable (i.e., accurate use vs error).

We then examined the distribution of the mean accuracy across the 10,000 simulated data sets. We also looked at the change in accuracy in percentage that was associated with a unit (i.e., 1 *SD*) change in our three focal predictor variables (i.e., frequency, reliability, and ΔP) when the other quantitative predictors were at their mean values and L1 type was ABSENT (i.e., reference level).

Figure S3.1 shows the distribution of the mean accuracy in each of the target morphemes. The figure shows that the distribution was close to a normal distribution with the mean around 0.50. This was expected given that the priors for the intercept and slope coefficients were symmetrical with respect to 0 in the logit scale, which corresponds to 0.50 in probability. The distributions seemed reasonable in that without looking at the actual accuracy data, we might indeed have expected the mean accuracy to be around 50%, but that there is some chance that it falls around 30% (or 70%).

This prior predictive distribution, however, turned out not to be very consistent with the observed data, whose mean accuracy was higher than initially expected (over 80% or 90%). We address this issue as part of the sensitivity analysis in Appendix S4.

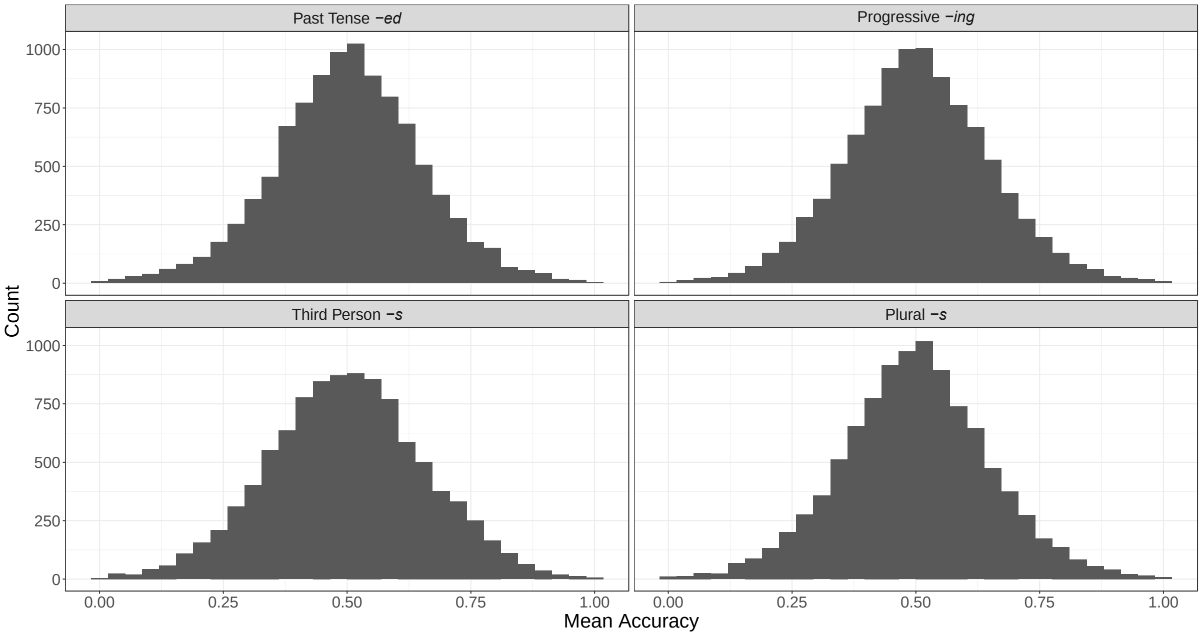

Figure S3.1 The distribution of mean accuracy in prior predictive distributions

Figure S3.2 illustrates the accuracy difference between the mean and the mean plus 1 standard deviation when the other predictor variables take their mean values or the reference level. As can be seen, prior distributions alone predict that a change in 1 standard deviation in one predictor is associated with the accuracy difference of approximately 0% to 20%. If a large portion is allocated to the region as high as 30% to 40%, for instance, the concerned predictor would practically dominate the factors influencing the accuracy, which perhaps is too strong an assumption. The values 0% to 20% are arguably reasonable from this perspective.

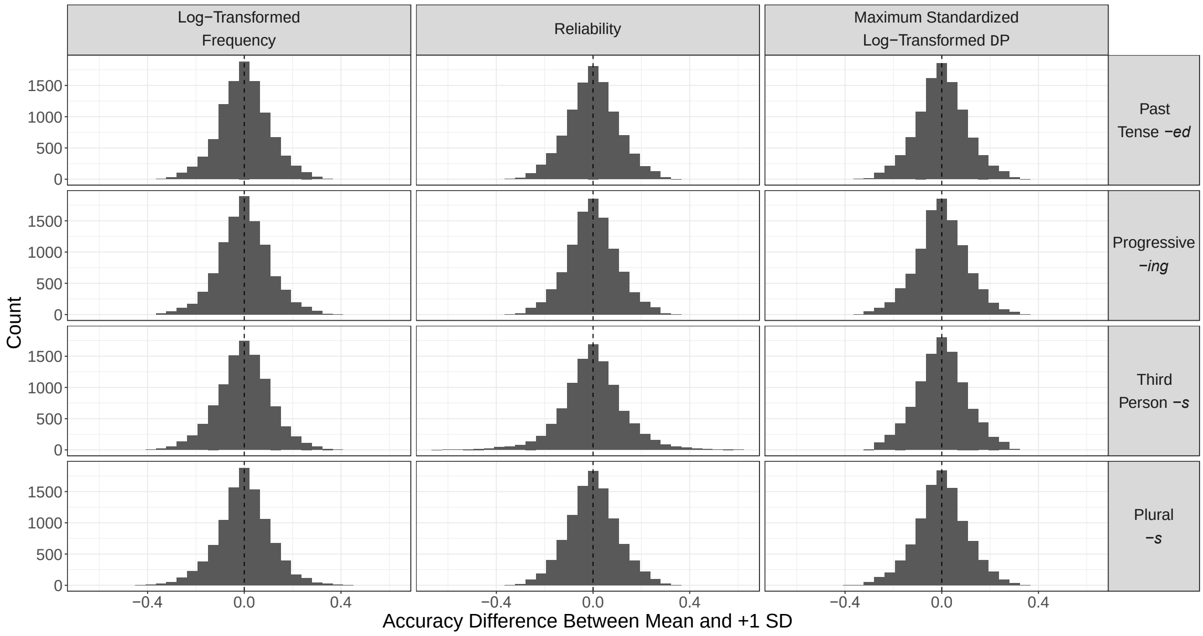

Figure S3.2 Distribution of the accuracy difference between mean and mean +1 standard deviation in each focal predictor in each morpheme in prior predictive distributions

Reference

Schad, D. J., Betancourt, M., & Vasishth, S. (2021). Toward a principled Bayesian workflow in cognitive science. *Psychological Methods, 26*, 103–126. https://doi.org/10.1037/met0000275

Appendix S4: Model Diagnostics

Trace Plots

Figures S4.1 through S4.4 are the trace plots of the fixed-effects parameters in each model. Chains appear to be mixed well in all the plots.

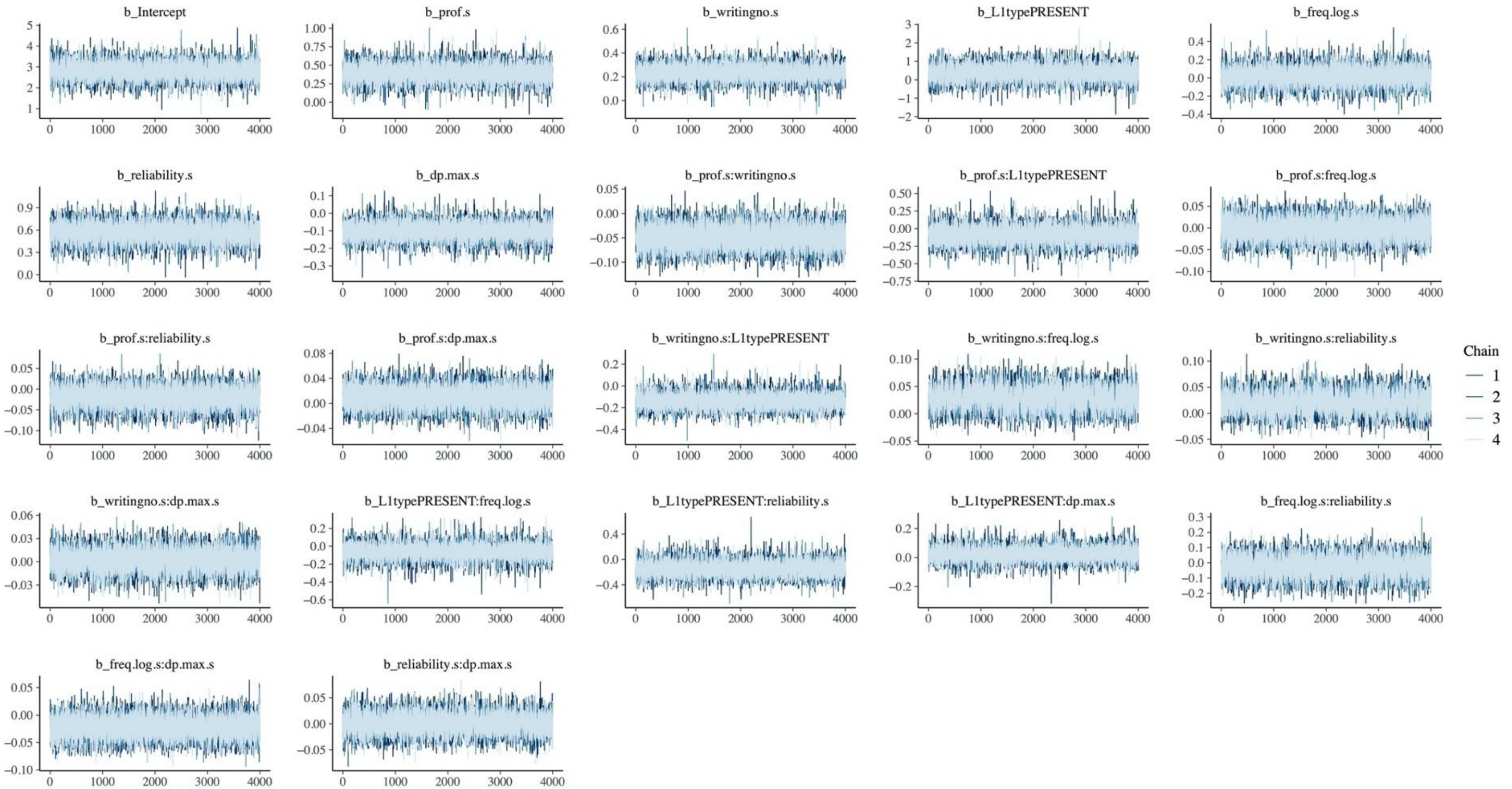

Figure S4.1 Trace plot of past tense *-ed*. The prefix b_ means that the parameter is an intercept, a slope, or a contrast, while the suffix .s indicates that the variable was standardized. prof = proficiency; writingno = writing number; L1typePRESENT = L1 type with the ABSENT group as the reference level; freq.log = log-transformed frequency; dp.max = maximum standardized log-transformed ΔP.

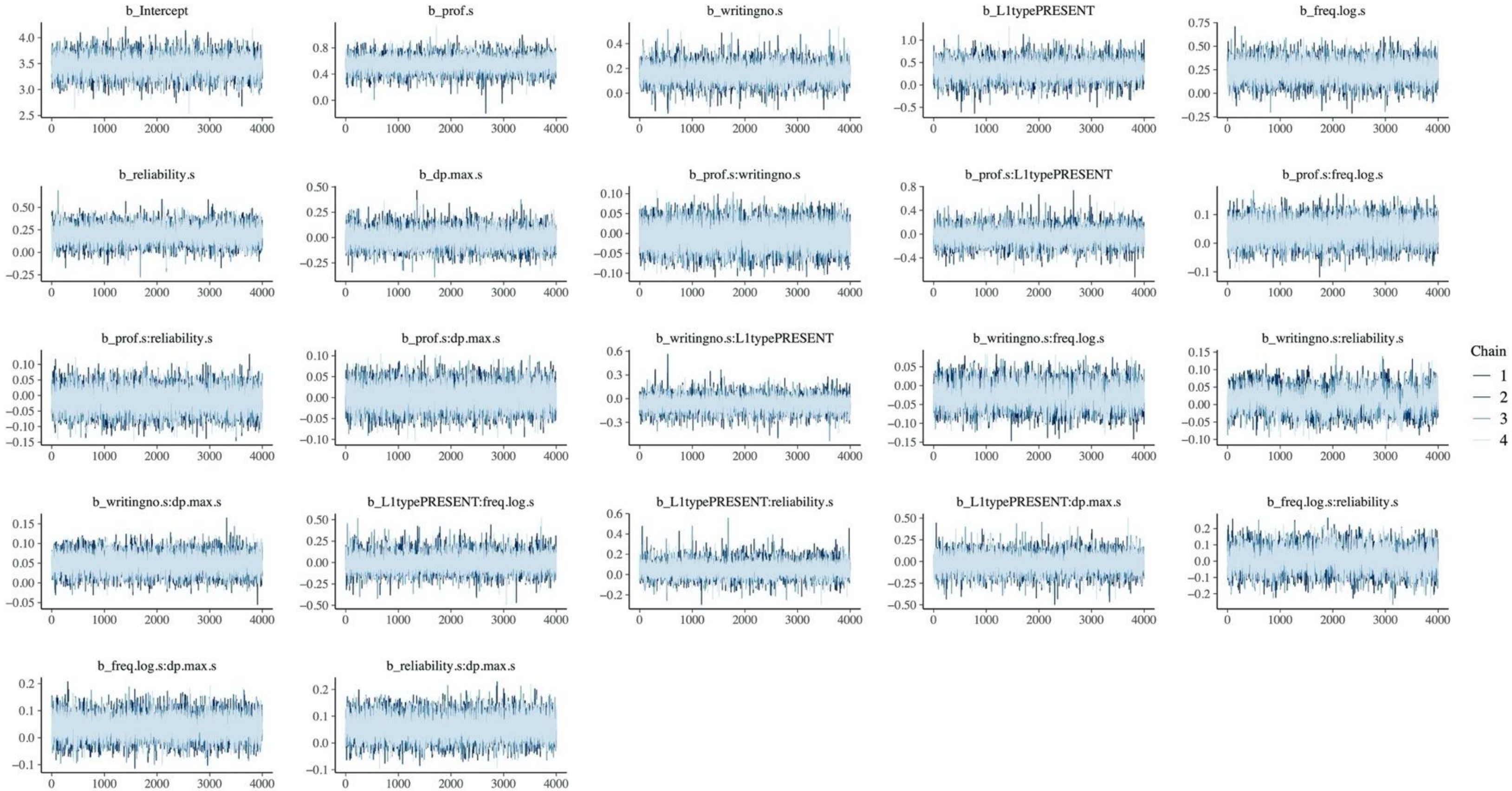

Figure S4.2 Trace plot of progressive *-ing*. The prefix b_ means that the parameter is an intercept, a slope, or a contrast, while the suffix .s indicates that the variable was standardized. prof = proficiency; writingno = writing number; L1typePRESENT = L1 type with the ABSENT group as the reference level; freq.log = log-transformed frequency; dp.max = maximum standardized log-transformed ΔP.

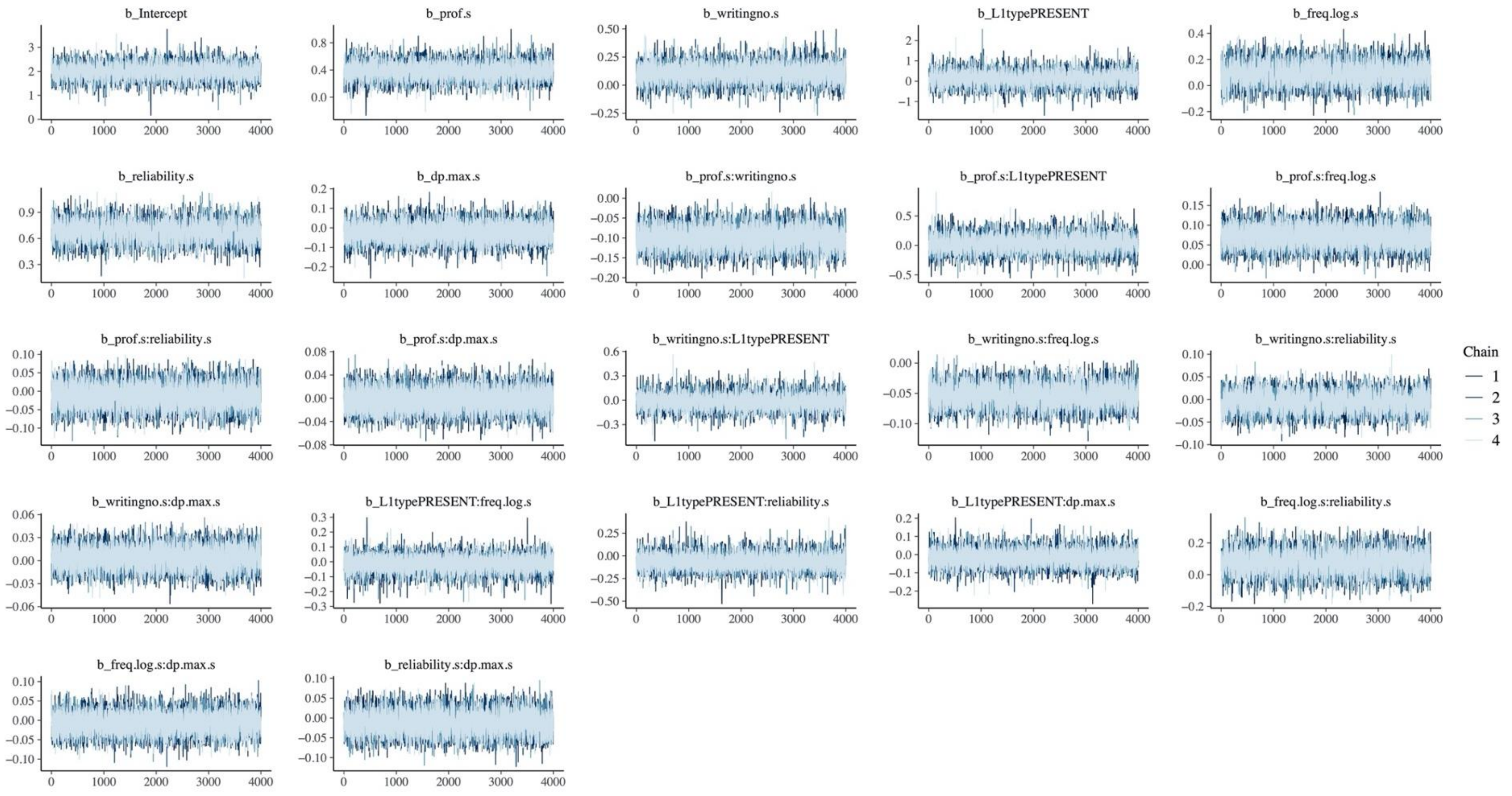

Figure S4.3 Trace plot of third person *-s*. The prefix b_ means that the parameter is an intercept, a slope, or a contrast, while the suffix .s indicates that the variable was standardized. prof = proficiency; writingno = writing number; L1typePRESENT = L1 type with the ABSENT group as the reference level; freq.log = log-transformed frequency; dp.max = maximum standardized log-transformed ΔP.

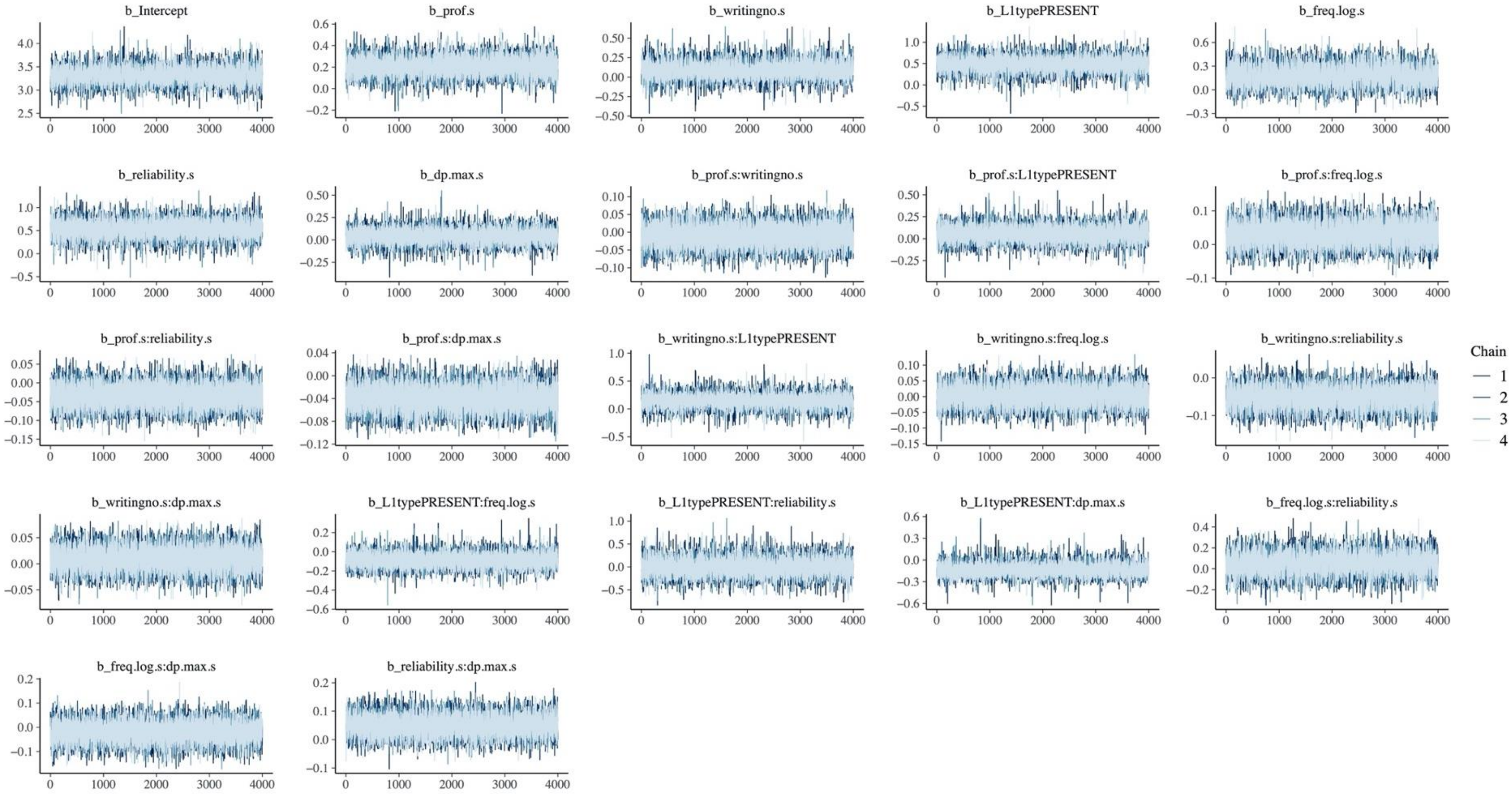

Figure S4.4 Trace plot of plural -*s*. The prefix b_ means that the parameter is an intercept, a slope, or a contrast, while the suffix .s indicates that the variable was standardized. prof = proficiency; writingno = writing number; L1typePRESENT = L1 type with the ABSENT group as the reference level; freq.log = log-transformed frequency; dp.max = maximum standardized log-transformed ΔP.

Posterior Predictive Checks

Posterior predictive checks are just like prior predictive checks, except that the obtained parameter estimates are used to generate hypothetical data instead of using the values drawn from prior distributions. By comparing the data simulated in this manner and actual observed data, researchers can confirm whether their models successfully capture the properties of the data that are of interest. Figure S4.5 shows the observed accuracy and the distribution of mean accuracy in posterior predictive distributions. The observed accuracy represented by vertical lines was within the posterior predictions (i.e., histograms), which suggested that posterior predictive distribution was in line with empirical data. Figure S4.6 shows the distribution of the accuracy difference between the mean and mean plus 1 standard deviation when the other predictor variables took their mean values or the reference level. The estimated accuracy difference tended to be less than 10%, which was in line with the specification of prior distributions.

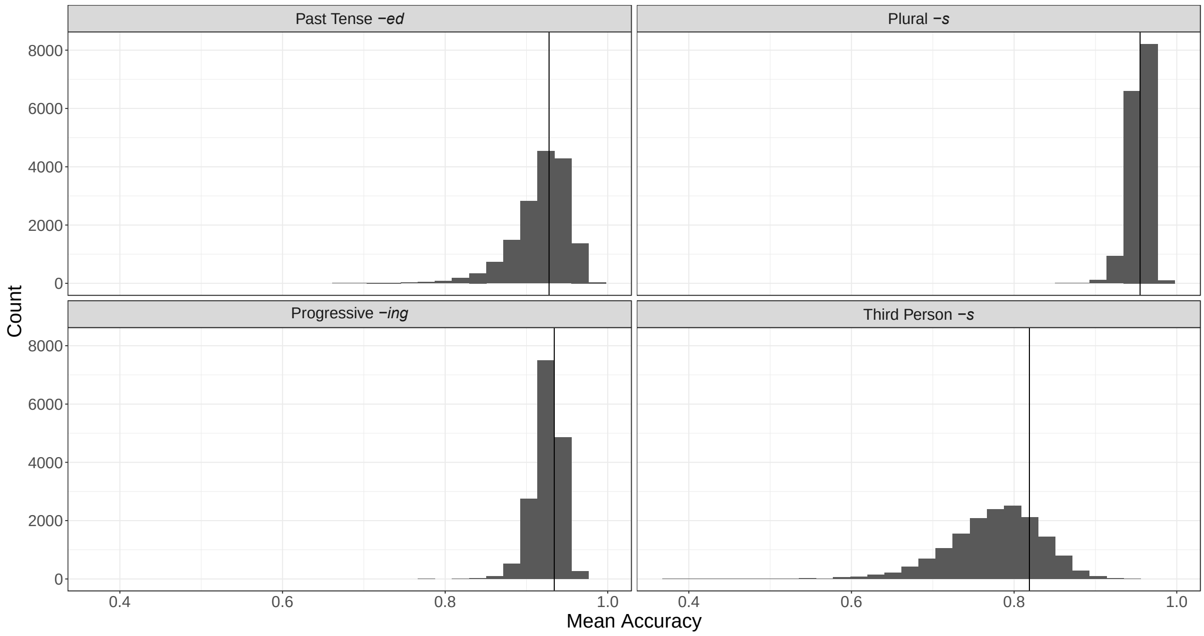

Figure S4.5 The distribution of mean accuracy in posterior predictive distributions**.** The vertical lines represent observed mean accuracy in each morpheme.

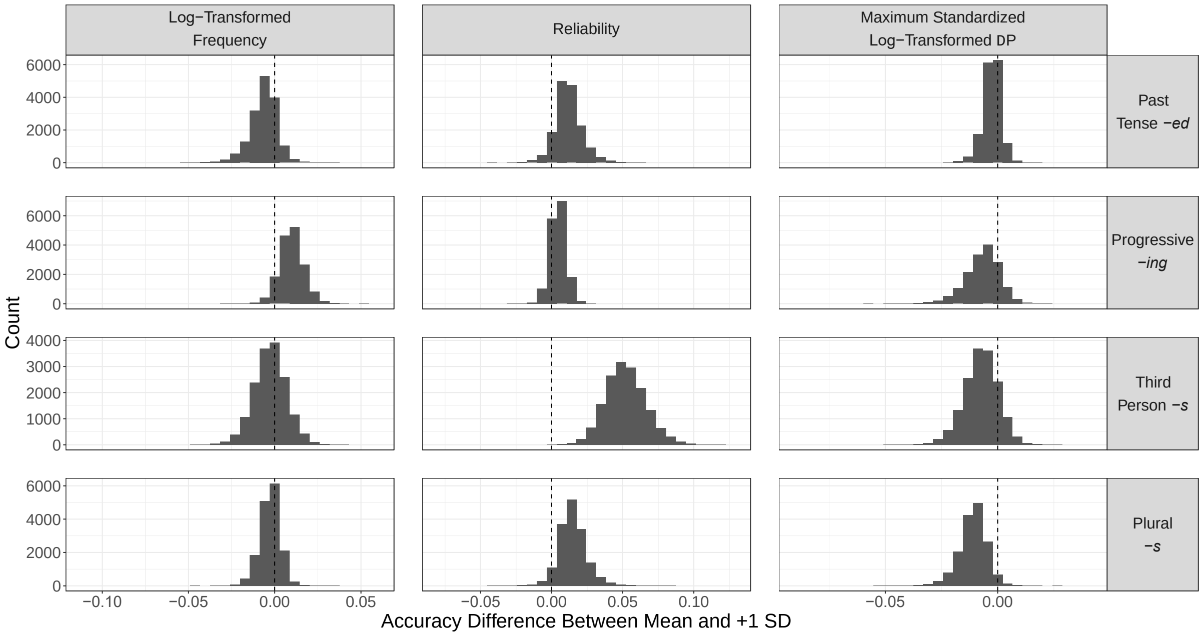

Figure S4.6 Distribution of the accuracy difference between mean and mean + 1 standard deviation in each focal predictor in each morpheme in posterior predictive distributions**.** The vertical lines represent the point where the predictor is unrelated to the accuracy of each morpheme.

Sensitivity Analysis

As we saw in Figure S3.1 in Appendix S3, our priors resulted in the very small probability allocated to over 90% mean accuracy, which was what we actually observed in our data. Our priors, therefore, were not very consistent with the data. In order to investigate the potential effect of this inconsistency, we built another group of models with different prior specification. More specifically, we used a normal distribution with a larger standard deviation (*SD* = 10) as a prior for the intercept. The rest of the model-building procedure was the same as that explained in the main text. Figure S4.7 shows prior predictive distributions based on the new prior specification. As the figure shows, higher probability has been allocated to higher mean accuracy (e.g., > 90%), being more consistent with the observed data. The accuracy change brought by 1 standard deviation change in our focal predictors (Figure S4.8) looked reasonable as well.

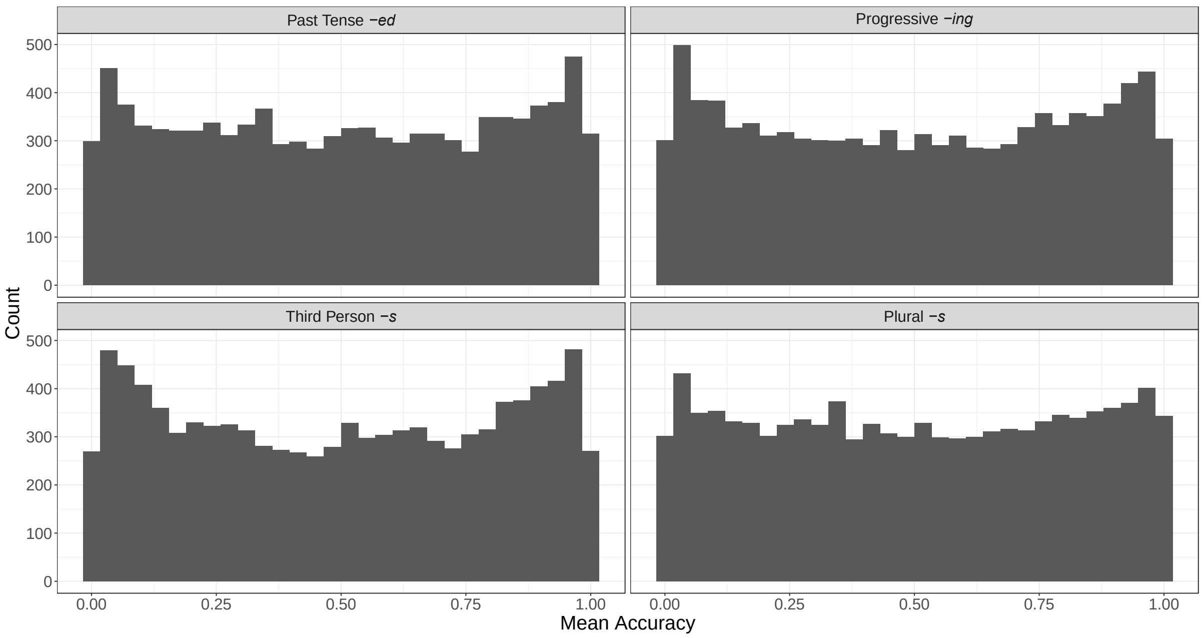

Figure S4.7 The distribution of mean accuracy in prior predictive distributions with more weakly informative priors for the intercepts (normal distribution with *SD* = 10).

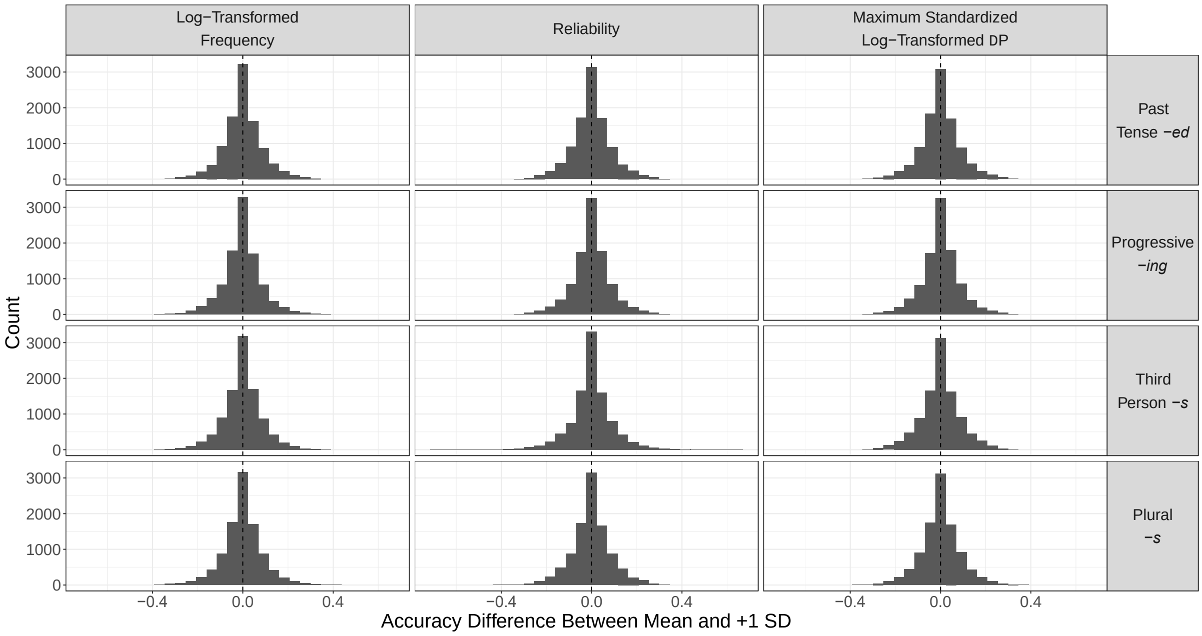

Figure S4.8 Distribution of the accuracy difference between mean and mean + 1 standard deviation in each focal predictor in each morpheme in prior predictive distributions with more weakly informative priors for the intercepts (normal distribution with *SD* = 10).

Figures S4.9 and S4.10 show posterior predictive distributions. Neither of them points to any significant issues with the models.

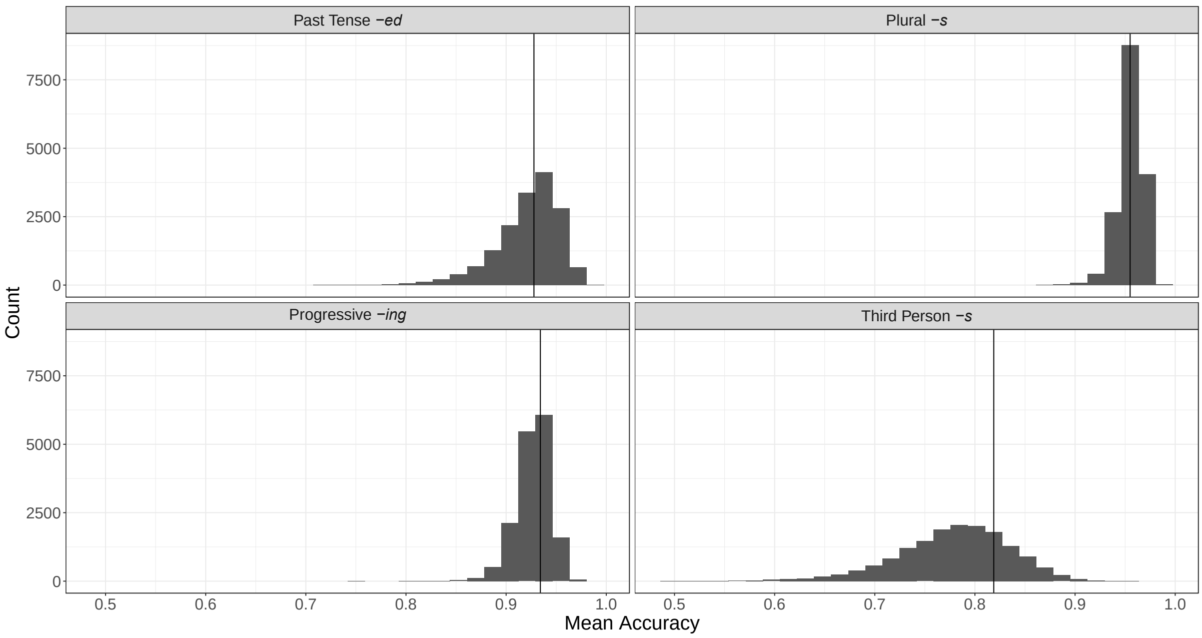

Figure S4.9 The distribution of mean accuracy in posterior predictive distributions when more weakly informative priors for the intercepts (normal distribution with *SD* = 10) were used**.** The vertical lines represent observed mean accuracy in each morpheme.

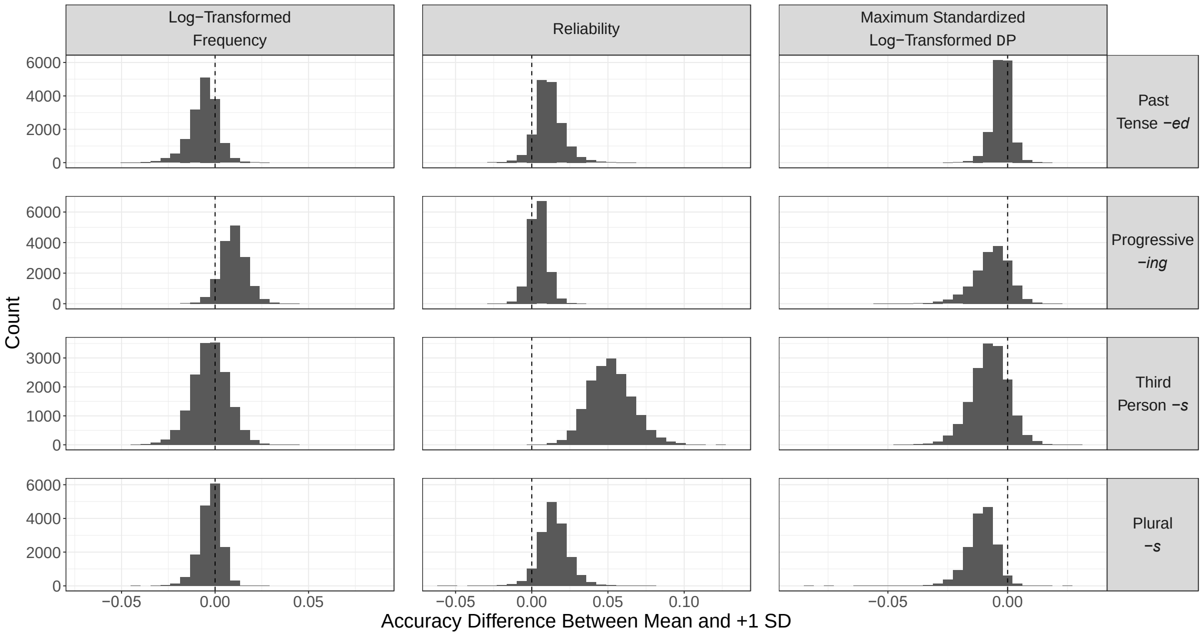

Figure S4.10 Distribution of the accuracy difference between mean and mean + 1 standard deviation in each focal predictor in each morpheme in posterior predictive distributions when more weakly informative priors for the intercepts (normal distribution with *SD* = 10) were used**.** The vertical lines represent the point where the predictor is unrelated to the accuracy of each morpheme.

In order to further examine the extent to which priors influenced the parameter estimation, we also built another group of models with flat priors. The structure of the models and the parameter estimation method were the same as those explained in the main text.

Figure S4.11 shows the 95% credible intervals of the models with weakly informative priors (i.e., same as those presented in Figure 2 in the main text), those with a prior normal distribution with a standard deviation of 10 for the intercept parameter and those with flat priors. We observed that the credible intervals were very similar between the three groups of models, thereby confirming that the estimation of our model parameters was not unjustifiably heavily driven by our specification of prior distributions.

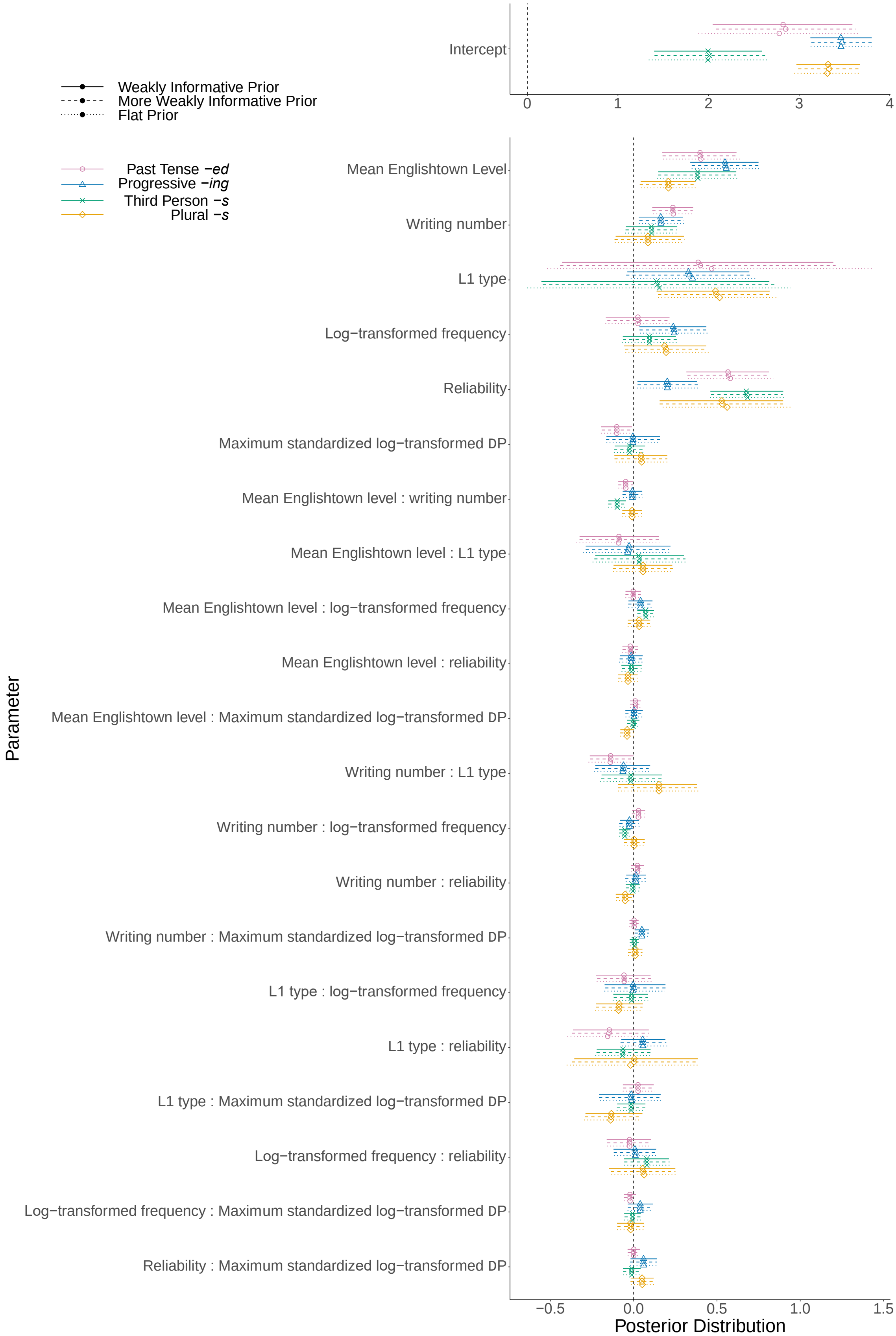

Figure S4.11 Posterior distribution of fixed-effects parameters in the models with flat and weakly informative prior distributions

Appendix S5: Numerical Summary of Posterior Distributions

Tables S5.1 and S5.2 show the numerical summary of the posterior distributions of both fixed- and random-effects parameters in each morpheme, while Figures S5.1 through S5.4 show the posterior distribution of each fixed-effects parameter in each morpheme in histograms.

Table S5.1 Summary of posterior distribution of each parameter in the models for past tense *-ed* and progressive *-ing*

		Past tense *-ed*			Progressive *-ing*		
			95% CI			95% CI	
Fixed vs. Random effects	Parameter	EAP	Lower	Upper	EAP	Lower	Upper
Fixed effects							
	Intercept	2.82	2.05	3.59	3.46	3.12	3.80
	Mean Englishtown level	0.40	0.17	0.62	0.55	0.34	0.75
	Writing number	0.24	0.11	0.36	0.16	0.03	0.30
	L1 type	0.39	–0.43	1.20	0.33	–0.04	0.69
	Log-transformed frequency	0.03	–0.17	0.22	0.24	0.03	0.44
	Reliability	0.57	0.32	0.81	0.20	0.02	0.38
	Maximum standardized log-transformed ΔP	–0.10	–0.19	-0.01	0.00	–0.16	0.16
	Mean Englishtown level : writing number	–0.05	–0.09	0.00	–0.01	–0.07	0.05
	Mean Englishtown level : L1 type	–0.09	–0.32	0.15	–0.03	–0.29	0.22
	Mean Englishtown level : log-transformed frequency	0.00	–0.05	0.04	0.04	–0.03	0.11
	Mean Englishtown level : reliability	–0.02	–0.07	0.03	–0.01	–0.08	0.05
	Mean Englishtown level : Maximum standardized log-transformed ΔP	0.01	–0.02	0.04	0.00	–0.05	0.06
	Writing number : L1 type	–0.14	–0.26	0.00	–0.06	–0.23	0.10
	Writing number : log-transformed frequency	0.03	–0.01	0.07	–0.03	–0.08	0.03
	Writing number : reliability	0.02	–0.02	0.06	0.01	–0.04	0.07
	Writing number : Maximum standardized log-transformed ΔP	0.00	–0.03	0.03	0.05	0.01	0.09
	L1 type : log-transformed frequency	–0.06	–0.23	0.10	0.00	–0.17	0.19
	L1 type : reliability	–0.15	–0.36	0.09	0.05	–0.07	0.19
	L1 type : Maximum standardized log-transformed ΔP	0.03	–0.07	0.12	–0.01	–0.21	0.16

Log-transformed frequency : reliability	–0.02	–0.16	0.10	0.01	–0.12	0.14
Log-transformed frequency : Maximum standardized log-transformed ΔP	–0.02	–0.06	0.01	0.04	–0.04	0.12
Reliability : Maximum standardized log-transformed ΔP	0.00	–0.04	0.04	0.06	–0.02	0.14
Random effects						
By-Inflected-Form						
SD of random intercepts	0.43	0.35	0.53	0.55	0.44	0.68
SD of the random slope of the mean Englishtown level	0.08	0.01	0.14	0.17	0.09	0.24
SD of the random slope of writing number	0.04	0.00	0.10	0.09	0.02	0.15
SD of the random slope of maximum standardized log-transformed ΔP	0.05	0.00	0.11	0.21	0.15	0.28
Correlation between intercepts and the mean Englishtown level	–0.33	–0.80	0.24	–0.27	–0.66	0.15
Correlation between intercepts and writing number	–0.08	–0.74	0.60	–0.52	–0.90	0.00
Correlation between the mean Englishtown level and writing number	0.15	–0.69	0.83	0.22	–0.44	0.78
Correlation between intercepts and maximum standardized log-transformed ΔP	0.20	–0.52	0.76	0.03	–0.34	0.39
Correlation between the mean Englishtown level and maximum standardized log-transformed ΔP	0.07	–0.74	0.80	–0.19	–0.61	0.27
Correlation between writing number and maximum standardized log-transformed ΔP	–0.12	–0.84	0.73	0.20	–0.38	0.71
By-Inflected-Form : Topic						
SD of random intercepts	0.55	0.50	0.59	0.88	0.81	0.95
By-Nationality						
SD of random intercepts	0.57	0.35	0.96	0.28	0.16	0.50
SD of the random slope of the mean Englishtown level	0.13	0.06	0.24	0.18	0.07	0.34
SD of the random slope of writing number	0.04	0.00	0.11	0.08	0.01	0.22
SD of the random slope of log-transformed frequency	0.08	0.03	0.17	0.12	0.05	0.23
SD of the random slope of reliability	0.14	0.07	0.25	0.07	0.00	0.18
SD of the random slope of maximum standardized log-transformed ΔP	0.03	0.00	0.08	0.12	0.05	0.23
Correlation between intercepts and proficiency	0.29	–0.31	0.76	–0.36	–0.81	0.24
Correlation between intercepts and writing number	0.18	–0.56	0.80	–0.30	–0.84	0.44
Correlation between the mean Englishtown level and writing number	0.17	–0.57	0.80	0.23	–0.50	0.80
Correlation between intercepts and log-transformed frequency	–0.08	–0.64	0.53	0.07	–0.53	0.63
Correlation between the mean Englishtown level and log-transformed frequency	–0.35	–0.85	0.32	–0.35	–0.83	0.28

	Correlation between writing number and log-transformed frequency	–0.10	–0.76	0.61	0.06	–0.60	0.69
	Correlation between intercepts and reliability	0.25	–0.31	0.71	0.22	–0.52	0.80
	Correlation between the mean Englishtown level and reliability	0.30	–0.32	0.81	–0.15	–0.77	0.60
	Correlation between writing number and reliability	0.22	–0.53	0.82	–0.11	–0.76	0.61
	Correlation between log-transformed frequency and reliability	–0.23	–0.78	0.40	0.03	–0.66	0.67
	Correlation between intercepts and maximum standardized log-transformed ΔP	0.04	–0.65	0.71	0.30	–0.31	0.78
	Correlation between the mean Englishtown level and maximum standardized log-transformed ΔP	0.17	–0.57	0.79	0.11	–0.51	0.68
	Correlation between writing number and maximum standardized log-transformed ΔP	0.07	–0.66	0.74	–0.17	–0.76	0.52
	Correlation between log-transformed frequency and maximum standardized log-transformed ΔP	–0.15	–0.78	0.59	–0.32	–0.81	0.33
	Correlation between reliability and maximum standardized log-transformed ΔP	0.19	–0.55	0.80	0.17	–0.55	0.77
By-Learner							
	SD of random intercepts	1.14	1.09	1.19	1.26	1.18	1.34
	SD of the random slope of writing number	0.43	0.36	0.50	0.32	0.19	0.43
	SD of the random slope of log-transformed frequency	0.30	0.20	0.39	0.37	0.18	0.52
	SD of the random slope of reliability	0.33	0.25	0.40	0.63	0.53	0.73
	SD of the random slope of maximum standardized log-transformed ΔP	0.08	0.00	0.17	0.16	0.05	0.26
	Correlation between intercepts and writing number	–0.32	–0.42	–0.21	–0.54	–0.76	–0.33
	Correlation between intercepts and log-transformed frequency	–0.05	–0.23	0.13	–0.19	–0.50	0.06
	Correlation between writing number and log-transformed frequency	0.17	–0.17	0.52	0.40	–0.10	0.82
	Correlation between intercepts and reliability	0.16	0.02	0.31	0.25	0.11	0.39
	Correlation between writing number and reliability	0.03	–0.28	0.32	–0.03	–0.38	0.35
	Correlation between log-transformed frequency and reliability	–0.52	–0.81	–0.21	–0.05	–0.41	0.35
	Correlation between intercepts and maximum standardized log-transformed ΔP	–0.26	–0.77	0.39	0.55	0.11	0.88
	Correlation between writing number and maximum standardized log-transformed ΔP	–0.07	–0.70	0.63	–0.16	–0.73	0.45
	Correlation between log-transformed frequency and maximum standardized log-transformed ΔP	–0.17	–0.77	0.57	–0.14	–0.69	0.49
	Correlation between reliability and maximum standardized log-transformed ΔP	0.26	–0.52	0.82	0.54	0.01	0.89
By-Topic							
	SD of random intercepts	0.41	0.29	0.54	0.51	0.39	0.65
	SD of the random slope of the mean Englishtown level	0.13	0.05	0.20	0.19	0.06	0.30

SD of the random slope of writing number	0.03	0.00	0.08	0.10	0.03	0.16
SD of the random slope of L1 type	0.34	0.21	0.47	0.33	0.22	0.45
SD of the random slope of log-transformed frequency	0.06	0.00	0.13	0.10	0.01	0.21
SD of the random slope of reliability	0.11	0.04	0.18	0.07	0.00	0.17
SD of the random slope of maximum standardized log-transformed ΔP	0.08	0.03	0.13	0.16	0.08	0.23
Correlation between intercepts and the mean Englishtown level	–0.21	–0.63	0.24	–0.27	–0.65	0.17
Correlation between intercepts and writing number	–0.01	–0.64	0.62	–0.45	–0.81	0.03
Correlation between the mean Englishtown level and writing number	0.00	–0.66	0.64	0.08	–0.50	0.60
Correlation between intercepts and L1 type	–0.60	–0.81	–0.28	–0.31	–0.60	0.05
Correlation between the mean Englishtown level and L1 type	0.05	–0.42	0.52	–0.07	–0.55	0.43
Correlation between writing number and L1 type	0.07	–0.58	0.70	–0.02	–0.52	0.50
Correlation between intercepts and log-transformed frequency	0.19	–0.48	0.73	–0.09	–0.64	0.49
Correlation between the mean Englishtown level and log-transformed frequency	–0.20	–0.75	0.49	–0.13	–0.70	0.53
Correlation between writing number and log-transformed frequency	0.00	–0.66	0.66	0.22	–0.47	0.76
Correlation between L1 type and log-transformed frequency	–0.01	–0.61	0.60	0.11	–0.52	0.68
Correlation between intercepts and reliability	–0.01	–0.49	0.44	–0.15	–0.69	0.49
Correlation between the mean Englishtown level and reliability	–0.45	–0.83	0.12	–0.14	–0.72	0.54
Correlation between writing number and reliability	0.04	–0.62	0.67	0.19	–0.49	0.75
Correlation between L1 type and reliability	–0.29	–0.71	0.21	0.22	–0.47	0.76
Correlation between log-transformed frequency and reliability	0.09	–0.56	0.68	0.16	–0.55	0.76
Correlation between intercepts and maximum standardized log-transformed ΔP	0.16	–0.29	0.57	0.02	–0.39	0.42
Correlation between the mean Englishtown level and maximum standardized log-transformed ΔP	–0.19	–0.67	0.36	–0.03	–0.56	0.49
Correlation between writing number and maximum standardized log-transformed ΔP	0.06	–0.63	0.68	–0.09	–0.63	0.46
Correlation between L1 type and maximum standardized log-transformed ΔP	–0.32	–0.73	0.17	–0.03	–0.46	0.42
Correlation between log-transformed frequency and maximum standardized log-transformed ΔP	0.07	–0.56	0.68	0.03	–0.59	0.65
Correlation between reliability and maximum standardized log-transformed ΔP	0.26	–0.29	0.73	–0.03	–0.65	0.61

Note. EAP = Expected a posteriori, which is the mean posterior value. CI = credible interval. The reference level of L1 type is the ABSENT group.

Table S5.2 Summary of posterior distribution of each parameter in the models for third person -*s* and plural -*s*

		Third person -*s*			Plural -*s*		
			95% CI			95% CI	
Fixed vs Random effects	Parameter	EAP	Lower	Upper	EAP	Lower	Upper
Fixed effects							
	Intercept	1.99	1.40	2.59	3.32	2.97	3.67
	Mean Englishtown level	0.38	0.15	0.62	0.21	0.04	0.37
	Writing number	0.11	–0.05	0.26	0.09	–0.11	0.30
	L1 type	0.14	–0.55	0.81	0.49	0.14	0.82
	Log-transformed frequency	0.09	–0.07	0.25	0.19	–0.06	0.44
	Reliability	0.68	0.46	0.90	0.53	0.16	0.90
	Maximum standardized log-transformed ΔP	–0.02	–0.11	0.07	0.04	–0.12	0.20
	Mean Englishtown level : writing number	–0.10	–0.15	–0.05	–0.01	–0.07	0.05
	Mean Englishtown level : L1 type	0.03	–0.23	0.30	0.06	–0.12	0.23
	Mean Englishtown level : log-transformed frequency	0.07	0.02	0.12	0.03	–0.04	0.10
	Mean Englishtown level : reliability	–0.01	–0.07	0.05	–0.03	–0.09	0.02
	Mean Englishtown level : Maximum standardized log-transformed ΔP	0.00	–0.04	0.03	–0.04	–0.08	0.00
	Writing number : L1 type	–0.02	–0.19	0.17	0.15	–0.09	0.38
	Writing number : log-transformed frequency	–0.05	–0.09	–0.02	0.00	–0.06	0.07
	Writing number : reliability	–0.01	–0.05	0.04	–0.05	–0.11	0.00
	Writing number : Maximum standardized log-transformed ΔP	0.00	–0.02	0.03	0.01	–0.03	0.05
	L1 type : log-transformed frequency	–0.01	–0.12	0.08	–0.09	–0.23	0.06
	L1 type : reliability	–0.06	–0.22	0.10	0.00	–0.36	0.39
	L1 type : Maximum standardized log-transformed ΔP	–0.01	–0.10	0.07	–0.13	–0.29	0.05
	Log-transformed frequency : reliability	0.08	–0.06	0.21	0.05	–0.15	0.25
	Log-transformed frequency : Maximum standardized log-transformed ΔP	–0.01	–0.06	0.04	–0.02	–0.10	0.06
	Reliability : Maximum standardized log-transformed ΔP	–0.01	–0.06	0.04	0.05	–0.02	0.12

Random effects						
By-Inflected-Form						
SD of random intercepts	0.70	0.59	0.82	0.71	0.59	0.85
SD of the random slope of the mean Englishtown level	0.15	0.09	0.21	0.13	0.07	0.19
SD of the random slope of writing number	0.05	0.01	0.10	0.10	0.03	0.17
SD of the random slope of maximum standardized log-transformed ΔP	0.17	0.10	0.24	0.19	0.13	0.26
Correlation between intercepts and the mean Englishtown level	0.03	–0.33	0.40	0.18	–0.24	0.59
Correlation between intercepts and writing number	–0.41	–0.84	0.22	–0.19	–0.63	0.32
Correlation between the mean Englishtown level and writing number	–0.35	–0.87	0.33	0.28	–0.35	0.79
Correlation between intercepts and maximum standardized log-transformed ΔP	0.16	–0.16	0.46	0.40	0.06	0.68
Correlation between the mean Englishtown level and maximum standardized log-transformed ΔP	0.10	–0.38	0.55	0.41	–0.09	0.86
Correlation between writing number and maximum standardized log-transformed ΔP	0.28	–0.43	0.80	0.22	–0.32	0.76
By-Inflected-Form : Topic						
SD of random intercepts	0.73	0.68	0.78	0.50	0.44	0.56
By-Nationality						
SD of random intercepts	0.58	0.35	0.96	0.21	0.08	0.42
SD of the random slope of the mean Englishtown level	0.19	0.10	0.35	0.06	0.00	0.17
SD of the random slope of writing number	0.10	0.01	0.22	0.13	0.02	0.28
SD of the random slope of log-transformed frequency	0.05	0.00	0.12	0.05	0.00	0.14
SD of the random slope of reliability	0.08	0.01	0.19	0.26	0.15	0.48
SD of the random slope of maximum standardized log-transformed ΔP	0.03	0.00	0.09	0.09	0.01	0.20
Correlation between intercepts and proficiency	0.28	–0.29	0.74	0.03	–0.67	0.70
Correlation between intercepts and writing number	–0.15	–0.68	0.47	–0.04	–0.66	0.60
Correlation between the mean Englishtown level and writing number	0.04	–0.58	0.64	0.14	–0.62	0.79
Correlation between intercepts and log-transformed frequency	0.12	–0.58	0.73	–0.17	–0.79	0.59
Correlation between the mean Englishtown level and log-transformed frequency	0.03	–0.64	0.67	–0.07	–0.74	0.66
Correlation between writing number and log-transformed frequency	–0.21	–0.81	0.55	–0.01	–0.70	0.69
Correlation between intercepts and reliability	0.12	–0.52	0.70	–0.21	–0.73	0.39
Correlation between the mean Englishtown level and reliability	0.00	–0.61	0.62	–0.02	–0.70	0.66

	Correlation between writing number and reliability	–0.07	–0.70	0.59	0.00	–0.59	0.60
	Correlation between log-transformed frequency and reliability	–0.10	–0.74	0.63	0.11	–0.61	0.75
	Correlation between intercepts and maximum standardized log-transformed ΔP	0.12	–0.59	0.73	–0.20	–0.77	0.50
	Correlation between the mean Englishtown level and maximum standardized log-transformed ΔP	–0.06	–0.71	0.63	–0.01	–0.70	0.69
	Correlation between writing number and maximum standardized log-transformed ΔP	–0.14	–0.78	0.59	0.18	–0.53	0.78
	Correlation between log-transformed frequency and maximum standardized log-transformed ΔP	–0.09	–0.75	0.65	0.04	–0.67	0.73
	Correlation between reliability and maximum standardized log-transformed ΔP	0.22	-0.54	0.81	–0.10	–0.70	0.56
By-Learner							
	SD of random intercepts	1.45	1.39	1.50	0.89	0.84	0.94
	SD of the random slope of writing number	0.56	0.48	0.64	0.38	0.31	0.46
	SD of the random slope of log-transformed frequency	0.46	0.39	0.53	0.37	0.29	0.44
	SD of the random slope of reliability	0.68	0.56	0.80	0.37	0.31	0.44
	SD of the random slope of maximum standardized log-transformed ΔP	0.10	0.01	0.23	0.20	0.07	0.29
	Correlation between intercepts and writing number	–0.43	–0.52	–0.34	0.05	–0.11	0.20
	Correlation between intercepts and log-transformed frequency	0.28	0.17	0.40	0.04	–0.12	0.21
	Correlation between writing number and log-transformed frequency	–0.49	–0.70	–0.27	–0.21	–0.48	0.07
	Correlation between intercepts and reliability	–0.18	–0.29	–0.08	0.04	–0.11	0.19
	Correlation between writing number and reliability	0.24	0.04	0.44	–0.09	–0.34	0.17
	Correlation between log-transformed frequency and reliability	–0.37	–0.54	–0.19	–0.20	–0.43	0.06
	Correlation between intercepts and maximum standardized log-transformed ΔP	0.19	–0.36	0.70	0.00	–0.28	0.29
	Correlation between writing number and maximum standardized log-transformed ΔP	–0.13	–0.72	0.51	–0.35	–0.80	0.07
	Correlation between log-transformed frequency and maximum standardized log-transformed ΔP	0.28	–0.42	0.82	0.16	–0.26	0.72
	Correlation between reliability and maximum standardized log-transformed ΔP	0.07	–0.60	0.66	-0.15	–0.58	0.25
By-Topic							
	SD of random intercepts	0.42	0.30	0.54	0.18	0.02	0.35
	SD of the random slope of the mean Englishtown level	0.14	0.03	0.23	0.05	0.00	0.12
	SD of the random slope of writing number	0.12	0.06	0.17	0.04	0.00	0.10
	SD of the random slope of L1 type	0.25	0.17	0.35	0.19	0.02	0.36
	SD of the random slope of log-transformed frequency	0.07	0.01	0.14	0.08	0.00	0.18

SD of the random slope of reliability	0.15	0.06	0.22	0.09	0.00	0.18
SD of the random slope of maximum standardized log-transformed ΔP	0.12	0.07	0.16	0.05	0.00	0.12
Correlation between intercepts and the mean Englishtown level	–0.09	–0.52	0.36	0.04	–0.63	0.67
Correlation between intercepts and writing number	–0.21	–0.60	0.23	0.19	–0.54	0.77
Correlation between the mean Englishtown level and writing number	0.07	–0.54	0.60	0.13	–0.60	0.75
Correlation between intercepts and L1 type	–0.53	–0.77	–0.18	–0.51	–0.92	0.38
Correlation between the mean Englishtown level and L1 type	0.31	–0.22	0.76	0.03	–0.62	0.67
Correlation between writing number and L1 type	0.19	–0.29	0.64	–0.12	–0.75	0.58
Correlation between intercepts and log-transformed frequency	–0.19	–0.70	0.43	–0.24	–0.78	0.47
Correlation between the mean Englishtown level and log-transformed frequency	0.08	–0.56	0.65	–0.03	–0.68	0.64
Correlation between writing number and log-transformed frequency	–0.17	–0.71	0.48	–0.03	–0.67	0.63
Correlation between L1 type and log-transformed frequency	–0.08	–0.65	0.53	0.11	–0.56	0.70
Correlation between intercepts and reliability	–0.41	–0.78	0.07	0.10	–0.57	0.68
Correlation between the mean Englishtown level and reliability	0.24	–0.35	0.72	–0.02	–0.68	0.65
Correlation between writing number and reliability	0.03	–0.50	0.56	–0.04	–0.68	0.64
Correlation between L1 type and reliability	0.14	–0.38	0.61	0.09	–0.57	0.67
Correlation between log-transformed frequency and reliability	0.25	–0.41	0.77	–0.18	–0.77	0.55
Correlation between intercepts and maximum standardized log-transformed ΔP	0.26	–0.12	0.61	–0.08	–0.68	0.58
Correlation between the mean Englishtown level and maximum standardized log-transformed ΔP	0.23	–0.31	0.70	0.09	–0.61	0.72
Correlation between writing number and maximum standardized log-transformed ΔP	0.04	–0.44	0.51	0.00	–0.66	0.66
Correlation between L1 type and maximum standardized log-transformed ΔP	0.00	–0.43	0.43	0.12	–0.56	0.71
Correlation between log-transformed frequency and maximum standardized log-transformed ΔP	–0.30	–0.78	0.37	–0.10	–0.72	0.60
Correlation between reliability and maximum standardized log-transformed ΔP	–0.08	–0.56	0.40	0.00	-0.64	0.65

Note. EAP = Expected a posteriori, which is the mean posterior value. CI = credible interval. The reference level of L1 type is the ABSENT group.

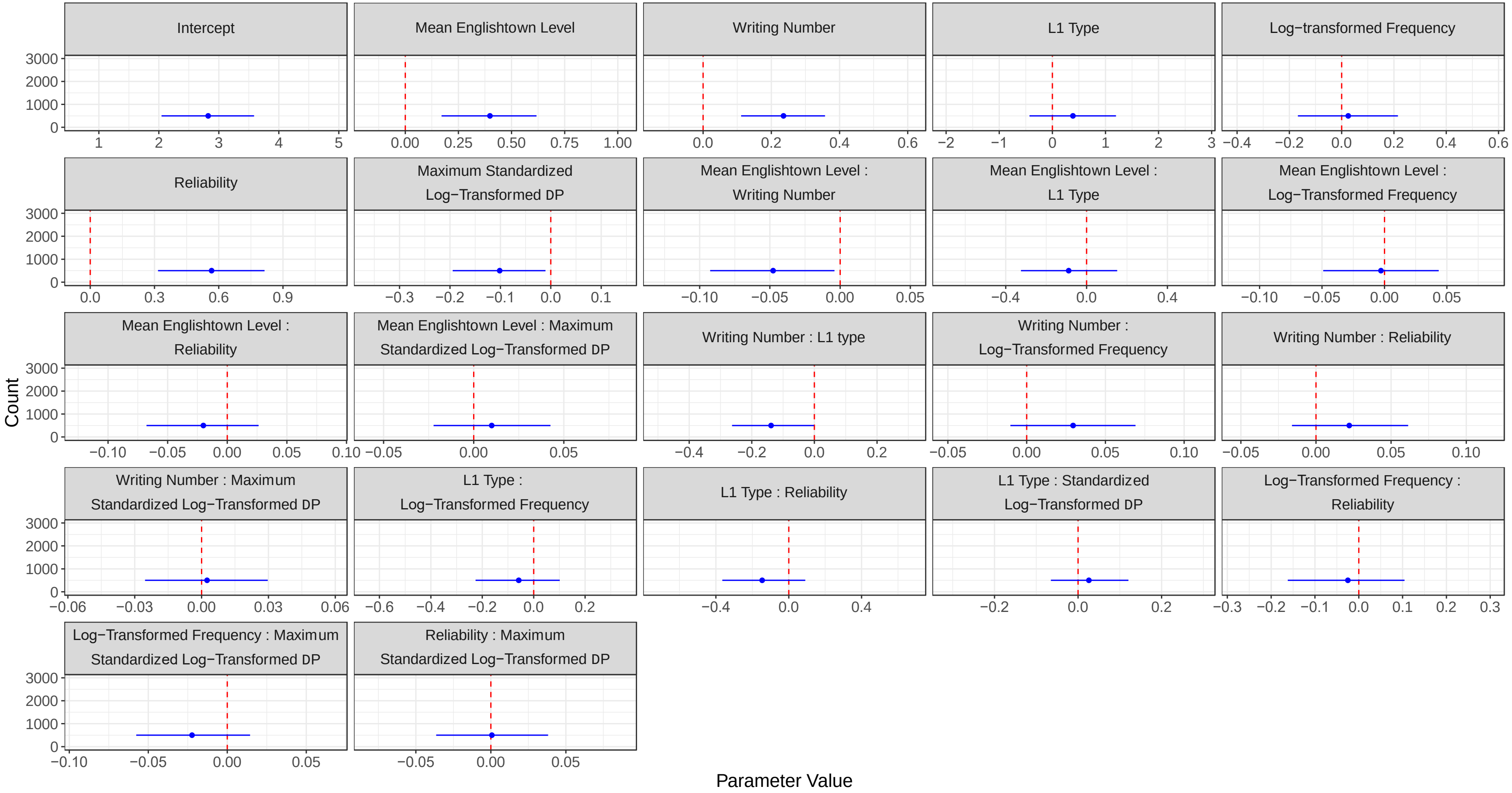

Figure S5.1 The posterior distribution of fixed-effects parameters in past tense *-ed*. The horizontal line indicates 95% credible interval, and the dot on the line represents the mean. The vertical line shows the point where there is no association between the parameter and the outcome variable.

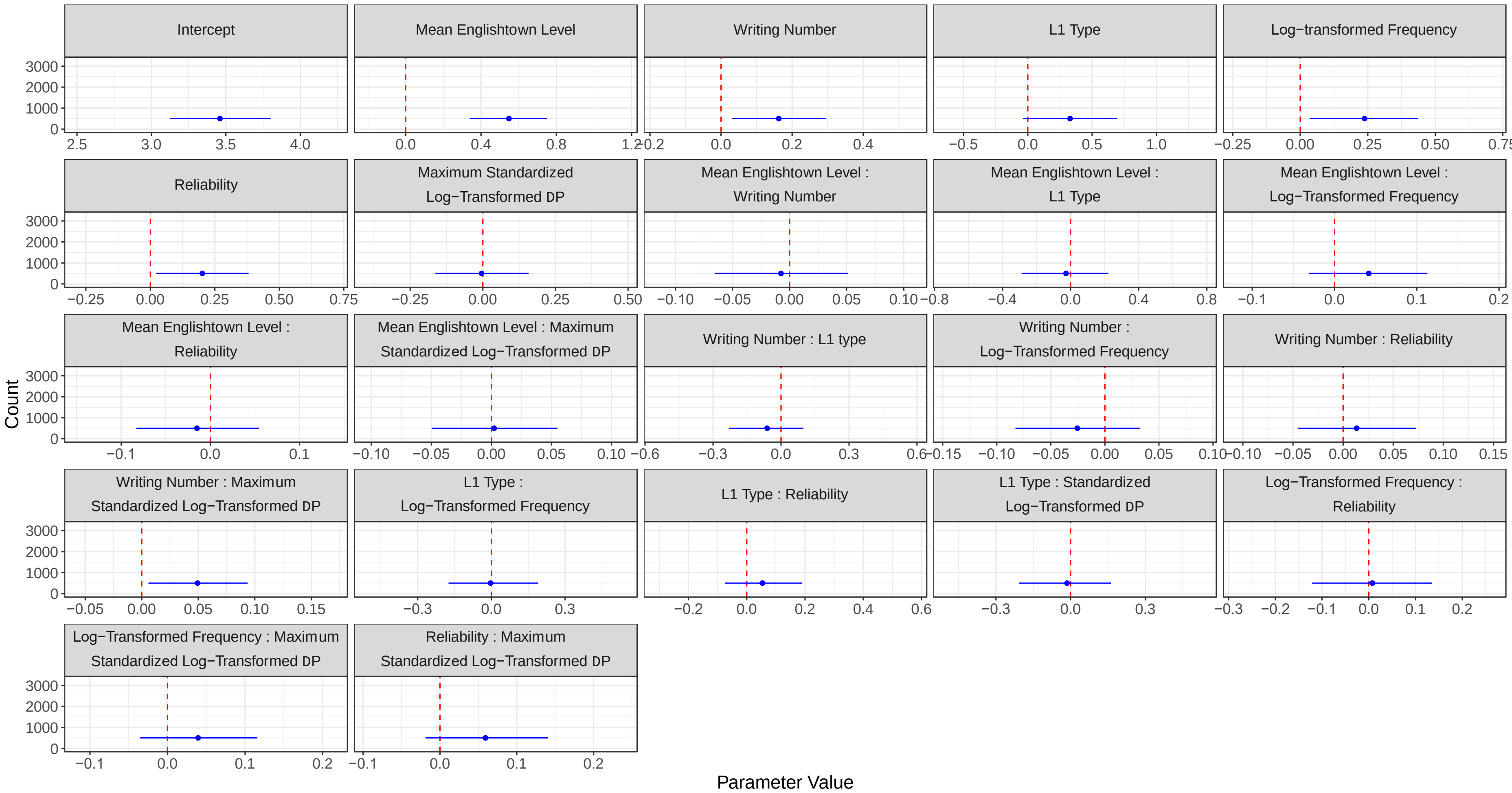

Figure S5.2 The posterior distribution of fixed-effects parameters in progressive *-ing*. The horizontal line indicates 95% credible interval, and the dot on the line represents the mean. The vertical line shows the point where there is no association between the parameter and the outcome variable.

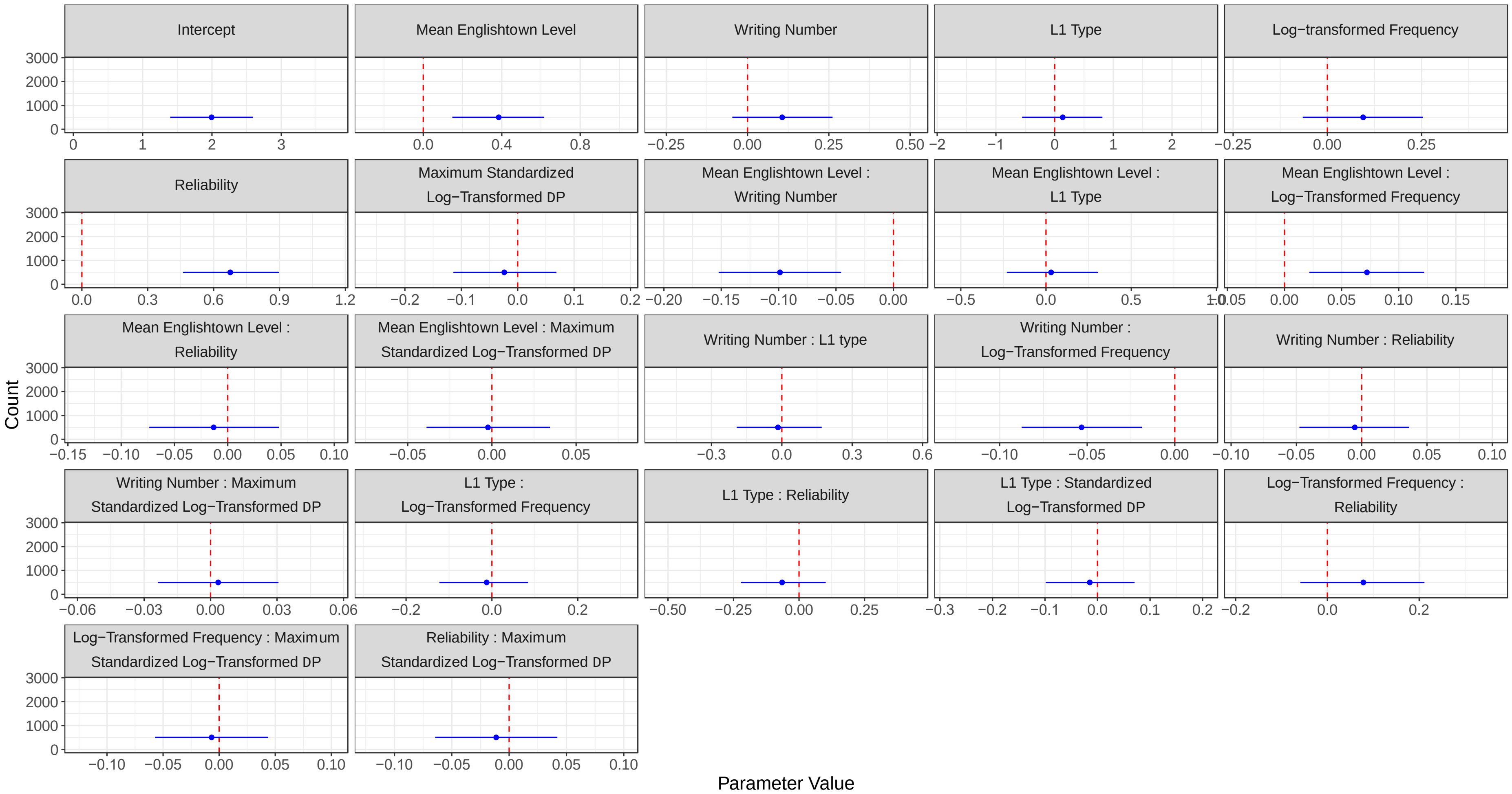

Figure S5.3 The posterior distribution of fixed-effects parameters in third person *-s*. The horizontal line indicates 95% credible interval, and the dot on the line represents the mean. The vertical line shows the point where there is no association between the parameter and the outcome variable.

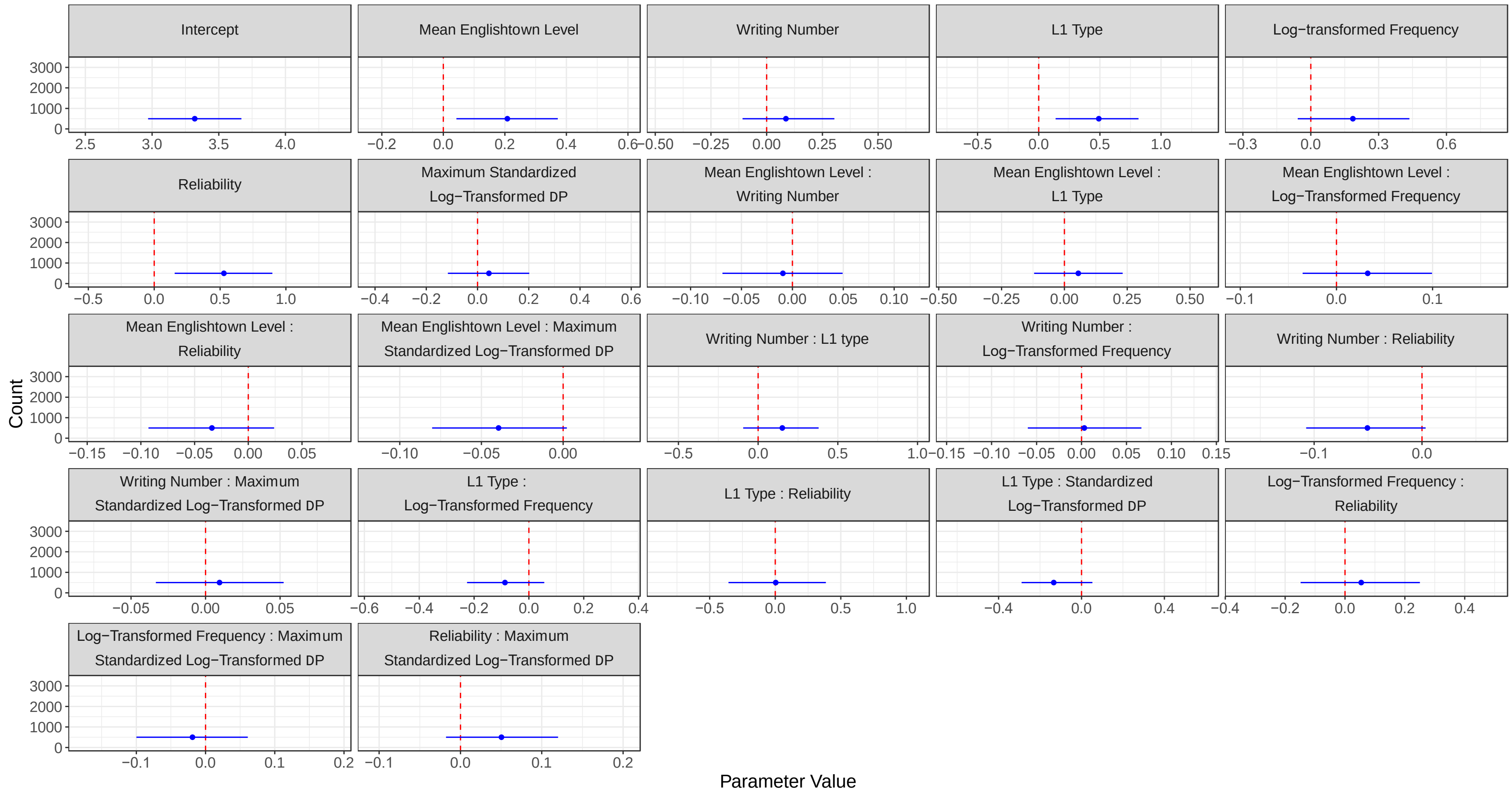

Figure S5.4 The posterior distribution of fixed-effects parameters in plural *-s*. The horizontal line indicates 95% credible interval, and the dot on the line represents the mean. The vertical line shows the point where there is no association between the parameter and the outcome variable.