Shallow by strategy: Heuristic parsing in Mandarin-Chinese-speaking learners' comprehension of Korean suffixal passives

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Abstract

This study examines how L1-Mandarin-Chinese L2-Korean learners comprehend constructions expressing transitivity within a good-enough processing framework. Using picture selection with webcam eye-tracking, we compare learners with native speakers in two studies. Study 1 crosses voice (active vs. passive), word order (canonical vs. scrambled), and verb position (verb-final vs. verb-initial). Learners are accurate for canonical actives, but perform below chance on passives and show reduced target looks in critical regions, consistent with a persistent agent-first bias and limited use of case-marking and passive morphology. Study 2 obscures case markers to isolate verbal morphology; learners favour agent-first interpretations and show only weak sensitivity to passive morphology. Across two studies, proficiency predicts more target-like performance, especially in non-canonical configurations. These findings highlight the role of cue alignment/(re)weighting in L2-acquisition pathways and a proficiency-mediated shift towards more algorithmic parsing, suggesting the dynamic and adaptive nature of L2 good-enough processing.

Keywords: Good-enough processing; Webcam eye-tracking; Proficiency; Passive; Korean; Mandarin Chinese

Introduction

The good-enough processing account maintains that sentence comprehension proceeds via two parallel routes: algorithmic parsing, which derives hierarchical structure from bottom-up cues, whether purely structure-driven (Ferreira & Clifton, 1986) or informed by probabilistic knowledge (Levy, 2008); and heuristic parsing, which relies on computationally cheap, readily accessible options drawn from memory, including pre-packaged templates, distributional regularities, and world knowledge (Christianson, 2016; Ferreira, 2003). Research suggests that comprehenders often adopt a least-effort strategy in real-time processing, relying primarily on heuristics rather than algorithms, which underscores the role of experience- and usage-based knowledge alongside selective engagement of richer structural computation (Ellis, 2002; Goldberg & Ferreira, 2022). Provisional analyses are revised only when necessary, which can lead to misinterpretation of sentences that require structural reanalysis (Dwivedi, 2013; Ferreira, 2003; Karimi & Ferreira, 2016; Kharkwal & Stromswold, 2014).

In second-language (L2) contexts, this account remains under-explored. Studies show that L2 learners can engage both heuristic and algorithmic parsing, yet often favour heuristics, particularly when their grammatical representations are fragile. For example, Lim and Christianson (2013, 2015) found that Korean-speaking learners of English relied on surface templates unless task demands required deeper parsing. Tan and Foltz (2020) observed that Chinese-speaking learners of English allocated more resources to algorithmic analysis when comprehension questions probed clause-internal relationships. Lee et al. (2024) reported that Czech- and English-speaking learners of Korean preferred heuristics, with L1 typology and task demands modulating processing behaviours. These studies suggest that L2 good-enough processing is dynamically shaped by multiple factors such as individual profiles, task demands, and cross-linguistic influences.

Transitivity in Korean and Mandarin Chinese

Korean is an agglutinative, SOV language with rich case-marking and relatively flexible word order. Its canonical transitive pattern places a nominative-marked agent before an accusative-marked theme. Scrambling allows reversal of noun phrases, and verb movement to clause-initial position is possible, although infrequent. Suffixal passives employ a passive morpheme attached to the verb; the theme receives nominative case and the agent dative case. Thus, passive morphology and case-marking jointly signal a reversal of thematic roles. Verb-final passives necessitate revision of provisional interpretations once passive morphology appears, whereas verb-initial passives provide early verbal cues that may facilitate correct thematic-role assignment.

Passive morphology is a key disambiguating cue because it prompts re-evaluation of provisional mappings between thematic roles and case markers (from agent–nominative + recipient–dative to theme–nominative + agent–dative). This shift gives rise to competing interpretive strategies in transitive events (Shin, 2022): a *Theme-First* strategy (first nominal = theme) competing with an agent-first bias; a

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Nominative-as-Theme strategy (the nominative-marked nominal is the theme) competing with the active-voice agent–nominative mapping; and a *Dative-as-Agent* strategy (dative-marked nominal = agent) competing with the active-voice theme–accusative mapping. Because passive constructions are relatively infrequent, these passive-based strategies are typically weaker than entrenched active-voice knowledge.

Mandarin Chinese, by contrast, has a rigid SVO order, lacks morphological case-marking, and uses the particle *bei* for passivisation. The theme precedes the agent in passives, paralleling Korean suffixal passives, but there is no verb-final morphology; *bei* is preverbal and invariant.

(1) Example (Korean)
a. Canonical transitive construction (verb-final)
Ciswu-ka Minki-lul cap-ass-ta.
Ciswu-NOM Minki-ACC catch-PST-DCL[1]
'Ciswu caught Minki.'
b. Canonical suffixal passive construction (verb-final)
Minki-ka Ciswu-hanthey cap-hi-ass-ta.
Minki-NOM Ciswu-DAT catch-PSV-PST-DCL
'Minki was caught by Ciswu.'

(2) Example (Mandarin Chinese)
a. Transitive construction
Tá Xiaǒmíng zhuā-le Xiǎowáng.
3sg Xiaoming catch-PRF Xiaowang
'Xiaoming caught Xiaowang.'
b. Passive construction
Xiǎowáng bèi Xiaǒmíng zhuā-zhù le.
Xiaowang bei Xiaoming catch-hold PRF
'Xiaowang was caught by Xiaoming.'

This structural mismatch is predicted to reduce transparency and increase learning difficulty for Mandarin-Chinese-speaking learners of Korean (cf. the morphological congruency hypothesis; Jiang et al., 2017). Case-marking further differentiates the systems: Mandarin Chinese lacks dedicated case-marking, whereas Korean relies on overt case markers whose role–case mappings shift in passives (e.g., nominative and dative marking themes and agents, respectively). Because these mappings are relatively infrequent and atypical, they may impose additional demands on learners. Overall, cross-linguistic differences in passive morphology and case coding are expected to increase processing costs and reduce comprehension accuracy in L1 Mandarin Chinese–L2 Korean learners.

Present study

The differing timing and locus of disambiguation in suffixal-passive patterns, relative to their active counterparts, allows us to examine whether L2-Korean learners rely primarily on heuristics (e.g., canonical word order; typical mappings between thematic roles and case markers) or can engage algorithmic routines (e.g., revising provisional analyses in response to passive morphology) during comprehension. Manipulating verb position (verb-final vs verb-initial) further tests how learners negotiate these routes as a function of L2 knowledge, given that passive-driven interpretive strategies are typically weaker than entrenched active-voice routines.

We therefore examine whether L1 Mandarin–L2 Korean learners use Korean case markers and passive morphology when successful comprehension requires revision. To this end, we employ picture selection combined with webcam-based eye-tracking. We predict that learners will perform well on canonical actives but struggle with passives, particularly in scrambled or verb-final conditions that require late reanalysis. If learners reliably exploit passive morphology, verb-initial passives should yield improved performance; by contrast, predominant reliance on heuristics should produce persistent misanalysis across conditions. Proficiency may modulate these effects, with more experienced learners more readily deploying algorithmic routines and showing more target-like performance.

Study 1: Processing of active and passive constructions

Methods

Forty-nine Mandarin-Chinese-speaking learners of Korean (mean age: 27 years, SD = 4) and fifty-six native Korean speakers (mean age: 24 years, SD = 4) participated. Learners had resided in Korea for an average of 38 months and had studied Korean for about 37 months. All participants gave informed consent. Learner proficiency was assessed with the Korean C-test (Lee-Ellis, 2009), a cloze test measuring comprehension of passages with syllable-level blanks. Scores (max: 188) averaged 111 (SD = 35).

We created 48 sentence stimuli. Active transitives crossed six verbs, two word orders (canonical vs scrambled), and two verb positions (verb-final vs verb-initial). Suffixal passives used six different verbs and the same word-order and verb-position manipulations. Agents and themes were animal characters to ensure semantic reversibility and avoid animacy bias. Each sentence was paired with two pictures depicting the same action with reversed thematic roles. Half the trials showed the agent on the left and half on the right, and target positions were counterbalanced.

As verb-initial sentences are unusual in isolation, a separate norming study confirmed that native speakers judged them largely acceptable. Auditory stimuli were generated with Google Text-to-Speech and included 1000-ms pauses between phrases to allow gaze measurement. Sentences were matched for length across conditions.

Participants completed a language background questionnaire and the C-test (learners only) before starting the eye-tracking experiment. Using *WebGazer.js* (Papoutsaki et al., 2016) for webcam eye-tracking, the visual-world task displayed two pictures side by side with a small margin. After a 12-point calibration, each trial presented the pictures for 2000 ms before sentence onset. Participants listened to the

[1] Abbreviations: 3SG = 3rd person singular; ACC = accusative case marker; CL = classifier; DAT = dative marker; DCL = ending, declarative; NOM = nominative case marker; PRF = perfective particle; PST = past tense marker; PSV = passive suffix.

auditory stimulus and pressed an arrow key to select the matching picture. Eye movements were recorded in 50 ms bins from picture onset until 2000 ms after sentence offset. Trials with blinks, head movements, or fixations in screen margins were excluded.

Picture-selection data were analysed with logistic mixed-effects models in R, with fixed effects for *Group* (native vs learner), *Voice* (active vs passive), *Word Order* (canonical vs scrambled), and *Verb Position* (verb-final vs verb-initial). Random intercepts for participants and items were included where possible. Eye-gaze analyses used non-parametric permutation tests to identify time windows where fixations to the target differed across groups. Further analyses employed generalised additive mixed models (GAMMs) to examine proficiency effects on gaze patterns over time, modelling smooth effects of time and proficiency for each region of interest (first noun, second noun, verb).

Results

Picture selection (Figure 1 & Table 1) Learners performed well on canonical actives regardless of verb position. In scrambled actives, accuracy decreased, and in all passive conditions performance fell below chance. Verb position did not significantly affect accuracy for either group. A three-way interaction between *Group*, *Voice,* and *Word Order* indicated that learners' difficulty was specific to scrambled and passive sentences. Bonferroni-corrected post-hoc pairwise comparisons showed significant differences between learners and natives in all passive and scrambled active conditions, but no significant difference in canonical actives. Proficiency predicted learner accuracy in scrambled actives and most passive conditions: higher proficiency led to improved picture selection when sentences deviated from agent-first order or relied on L2-specific cues.

Table 1. Statistical outputs (picture selection, Study 1)

	β	*SE*	*z*	*p*	
(Intercept)	0.78	0.01	125.68		***
Group	–0.44	0.01	–35.22		***
Voice	–0.20	0.01	–16.40		***
WordOrder	–0.09	0.01	–7.08		***
VerbPosition	0.01	0.01	0.66	0.51	
Group×Voice	–0.42	0.02	–16.69		***
Group×WordOrder	–0.17	0.02	–6.72		***
Voice×WordOrder	0.19	0.02	7.62		***
Group×VerbPosition	0.01	0.02	0.62	0.53	
Voice×VerbPosition	–0.01	0.02	–0.09	0.93	
WordOrder×VerbPosition	0.01	0.02	0.04	0.97	
Group×Voice×WordOrder	0.41	0.05	8.26		***
Group×Voice×VerbPosition	–0.02	0.05	–0.46	0.64	
Group×WordOrder×VerbPosition	–0.02	0.05	–0.33	0.74	
Voice×WordOrder×VerbPosition	–0.04	0.05	–0.74	0.46	
Group×Voice×WordOrder ×VerbPosition	–0.04	0.10	–0.39	0.70	

Note. Due to model convergence issues, we conducted multiple logistic regression (without random effects) for this analysis. Nagelkerke's R^2: 0.473. $^{***}p < 0.001$.

Eye-tracking (Figure 2) Learners showed reduced target fixations compared with natives across conditions. In canonical verb-final actives, learners looked more at the target during the first noun (agent–nominative) but fewer times during the second noun (theme–accusative) and verb. In scrambled verb-final actives, learners' gaze remained flat, diverging from natives who increased target fixations when encountering the nominative-marked second noun and the verb. Verb-initial actives yielded similar group differences at the second noun, with learners looking less at the target.

For passives, learners fixated the incorrect picture in critical regions, especially late in verb-final sentences when passive morphology appeared. In verb-initial passives, learners' fixations indicated brief sensitivity to early passive morphology, but they soon reverted to an agent-first interpretation. Secondary analyses showed that learners' gaze was influenced by the thematic-role order of the pictures: when the target picture presented a theme-before-agent sequence, learners decreased looks relative to actives, reflecting the conflict between the passive cue and their default heuristic (i.e., the agent-first bias).

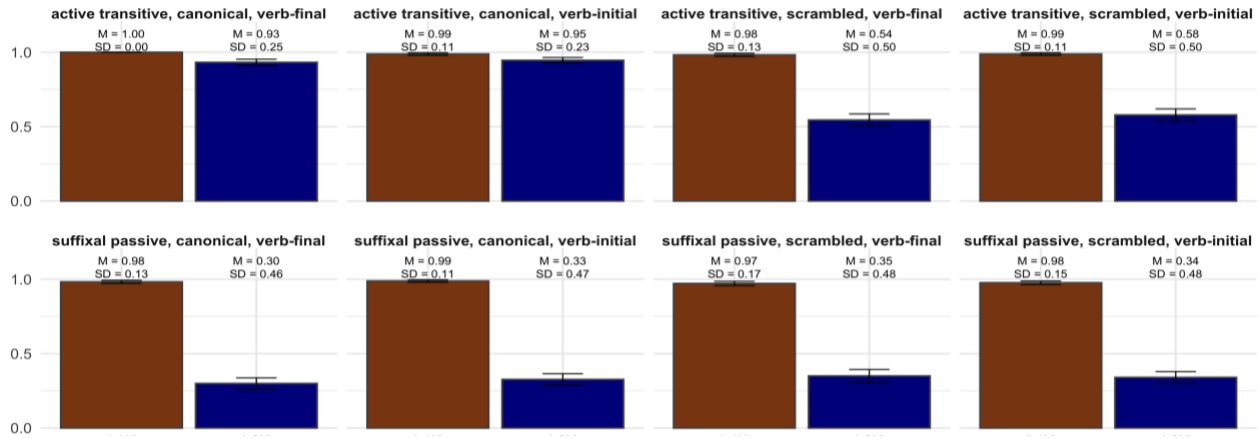

Figure 1. Results (picture selection, Study 1). X-axis: group (brown: NSK; blue: CHN). Y-axis: response (accuracy). M: mean, SD: standard error. Error bars indicate 95% confidence intervals (standard errors).

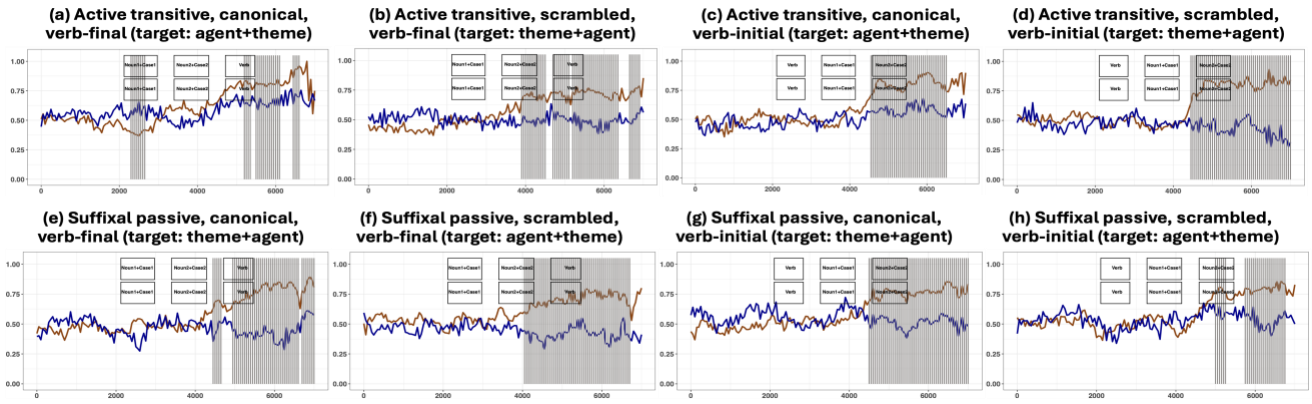

Figure 2. Results (eye-tracking, Study 1): CHN vs. NSK. X-axis: time (in ms); Y-axis: proportion of looks to the target. Brown: NSK; Blue: CHN. Sentence regions are indicated by rectangles. Grey shading denotes significant bins identified by permutation analysis.

GAMM analyses (Supplementary Materials A)[2] revealed that proficiency modulated eye-gaze patterns in region- and construction-specific ways. In canonical verb-final actives, increased proficiency shortened the time to fixate the verb. In scrambled actives, proficiency effects emerged at the second noun and verb, indicating that proficient learners were quicker to resolve non-canonical orderings. For passives, proficiency had stronger effects: in canonical verb-final passives, higher proficiency increased attention to the dative-marked agent and facilitated reanalysis at the verb; in scrambled passives, proficiency modulated fixations at the first noun and verb, indicating improved ability to reinterpret the first noun and integrate passive morphology. Verb-initial passives displayed proficiency effects primarily at postverbal nouns and verbs, with more proficient learners exploiting early verbal morphology cues more effectively.

Discussion

Learners successfully interpreted canonical actives but struggled with scrambled actives and all passive patterns. Their accuracy and eye-gaze patterns reflect a strong agent-first bias, transferred from their L1 (Mandarin Chinese), and limited reliance on L2-unique case-marking and passive morphology. Verb position did not affect performance, suggesting that early access to passive morphology in verb-initial sentences offered little advantage. Proficiency alleviated some difficulties: more advanced learners performed better on scrambled actives and exhibited more target-like eye gaze in passives, suggesting gradual adoption of algorithmic parsing. Nevertheless, even highly proficient learners remained vulnerable when both word order and voice deviated from the canonical compositions.

Study 2: Obscuring case markers to isolate passive morphology

Methods

To determine whether the difficulty with passives stemmed from conflicting case-marking, Study 2 removed case cues by masking case markers with cough sounds as in (3).

(3) Stimuli example (Study 2, verb-final suffixal passive)
Kangaci-*cough* koyangi-*cough* ccil-li-eyo.
dog-*cough* cat-*cough* poke-psv-dcl
'The dog/cat is poked by the cat/dog.'

The same participants completed a new set of 24 sentences crossing voice (active vs passive) and verb position (verb-final vs verb-initial). Agents and themes remained animal characters, and sentences were spoken by the same text-to-speech generator. Prior to the experiment, participants were told that the on-screen character had a cold and would cough during the recording. Responses were coded as agent-first or theme-first interpretations.

Results

Picture selection (Figure 3 & Table 2) Natives favoured theme-first interpretations in passives and agent-first interpretations in actives, with stronger theme-first responses

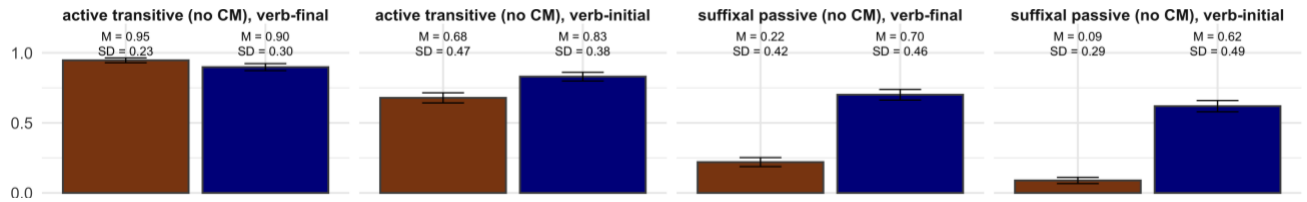

Figure 3. Results (picture selection, Study 2). X-axis: group (brown: NSK; blue: CHN). Y-axis: response (agent-first rate). M: mean, SD: standard error. Error bars indicate 95% confidence intervals (standard errors).

[2] https://osf.io/vweru/overview?view_only=f1b22ef21cec44ffaa89e845f617b622

in verb-initial passives. Learners, by contrast, showed little verb-position sensitivity: they selected agent-first interpretations in actives and continued to favour agent-first interpretations in passives, despite the absence of case cues. Proficiency was associated with an increase in theme-first responses in passives, but the effect was modest relative to native performance.

Table 2. Statistical outputs (picture selection, Study 2)

	β	*SE*	*z*	*p*	
(Intercept)	0.61	0.10	5.95		***
Group	1.29	0.17	7.68		***
Voice	–2.56	0.18	–14.28		***
VerbPosition	–1.09	0.17	–6.25		***
Group×Voice	2.46	0.34	7.34		***
Group×VerbPosition	1.14	0.33	3.41		***
Voice×VerbPosition	0.69	0.35	1.97	0.05	*
Group×Voice×VerbPosition	–0.86	0.67	–1.29	0.20	

Note. Conditional R^2: 0.479. $^{*}p < 0.05$; $^{***}p < 0.001$.

Eye-tracking (Figure 4) Learners' eye-gaze patterns echoed the picture-selection results. In verb-final actives, learners looked at the target picture more than natives during the early first noun and verb regions, reflecting reinforcement of agent-first interpretation. In verb-initial actives, both groups exhibited similar gaze patterns, diverging only slightly during the first noun. For passives, learners and natives showed comparable gaze patterns overall; however, natives increased looks to the target at the second noun in verb-initial passives, indicating integration of early passive-voice cues. Learners lacked this pattern and often fixated the wrong picture until late in the sentence.

GAMM analyses (Supplementary Materials B)[3] indicated that proficiency shaped learners' eye-gaze distribution in nuanced ways. In verb-final actives, proficiency modulated the timing of fixations on the second noun. In verb-initial actives, higher proficiency led to more balanced attention between the first and second nouns. For passives, proficiency increased learners' sensitivity to verbal morphology cues, particularly in verb-initial sentences, but the effect did not extend to reliable reanalysis of thematic roles. Overall, learners' reliance on the agent-first bias persisted, albeit with slight proficiency-mediated improvements.

Discussion

Removing case markers did not lead learners to rely more on passive morphology; instead, they continued to favour an agent-first interpretation. Natives exploited verb-initial passive morphology to infer theme-first structure, whereas learners did not. This suggests that case-marking alone did not cause misanalysis; rather, learners' heuristics were robust enough to override early passive cues. Proficiency again predicted more target-like responses, but even advanced learners displayed a strong agent-first bias. The results underscore that learners may underutilise morphological cues that are absent in their L1, even when such cues are salient.

General Discussion and Conclusion

Learners relied heavily on an L1-based word-order heuristic and made limited use of L2-specific cues such as case-marking and verbal morphology. This tendency was most evident for suffixal passives: learners performed below chance on passive items in Study 1, and they continued to favour agent-first interpretations even when case markers were obscured in Study 2. These outcomes align with the good-enough processing account, according to which comprehenders prioritise low-cost, experience-based procedures over structure-based analysis (Christianson, 2016; Ferreira, 2003). Rather than constructing a fully specified parse for every sentence, the L2 processor may settle on familiar, non-structural routines and adjust only when strongly compelled. In the current study, treating the first noun as the agent yielded a rapid and often plausible—although sometimes incorrect—interpretation for Korean active transitives, and learners appeared to generalise this heuristic across conditions.

These results corroborate and extend prior work on L2 good-enough processing. As in L1 comprehension, L2 processing appears to involve parallel engagement of both streams, coupled with a strong preference for cognitively efficient heuristics (Lim & Christianson, 2013; Tan & Foltz, 2020). Learners frequently under-utilised late-arriving cues such as passive morphology, particularly in verb-final sentences where passivisation necessitates demanding revision of an initial analysis. Eye-tracking revealed garden-path effects in these configurations: learners often fixated the incorrect picture in line with an initial active-voice interpretation and did not rapidly reorient towards the target even after passive morphology became available. This pattern suggests that the L2 processor tends to avoid costly

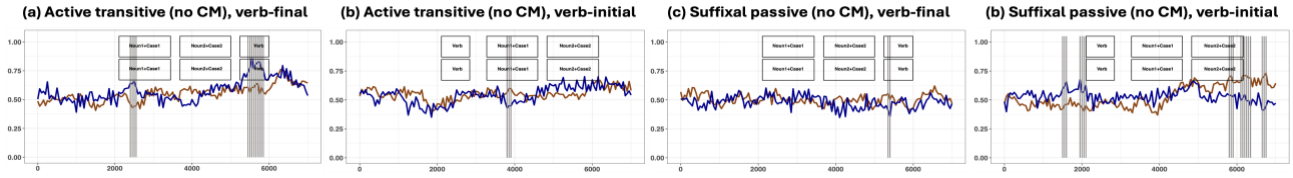

Figure 4. Results (eye-tracking, Study 2). X-axis: time (in ms); Y-axis: proportion of looks to the target. Brown: NSK; Blue: CHN. Sentence regions are indicated by rectangles. Grey shading denotes significant bins identified by permutation analysis. Case1 and Case2 were obscured by auditory effects.

[3] https://osf.io/vweru/overview?view_only=f1b22ef21cec44ffaa89e845f617b622

recomputation unless strongly required. Although successful picture selection ultimately depends on accurate role assignment, learners' real-time behaviour indicates delayed or incomplete revision, yielding persistently shallow interpretations in non-canonical contexts. Such behaviour accords with accounts in which L2 processing is strategically shallow (Clahsen & Felser, 2018; Omaki & Schulz, 2011): deeper parsing is available in principle, but its deployment depends on motivation, resources, and task demands. In our study, cognitive load and relatively fragile L2 grammatical representations may have suppressed full algorithmic parsing, thereby amplifying reliance on heuristics.

Cross-linguistic influence appears to be a key source of this good-enough profile. Mandarin Chinese encodes transitivity primarily through word order, with a relatively rigid SVO structure and no morphological case-marking. Learners appear to have transferred an agent-first bias into Korean comprehension, performing best when Korean sentences aligned with Mandarin expectations (e.g., canonical transitives) and declining sharply when those expectations were violated (e.g., scrambling or passive voice). Across both studies, learners showed a pervasive agent-before-theme preference, reflecting a dominant transitive template in Mandarin. In scrambled Korean suffixal passives (agent–dative + theme–nominative), learners performed poorly, plausibly because structural mismatches between Mandarin and Korean passives render this construction less transparent. More generally, typological differences in passive morphology and case coding are likely to increase processing costs and reduce comprehension accuracy: learners often failed to recognise passive morphology or to implement its interpretive consequences, instead over-applying L1-based expectations (e.g., treating a nominative-marked noun as an agent) even when this led them astray.

Our results are also compatible with L2-acquisition accounts. For example, the morphological congruency hypothesis (Jiang et al., 2017) predicts greater acquisitional difficulty when L2 cues lack straightforward counterparts in the L1. Here, the absence of case-marking and verbal inflection for passivisation in Mandarin Chinese may have left learners less prepared to exploit the grammatical devices that distinguish Korean suffixal passives, thereby reinforcing reliance on word-order heuristics. It is also consistent with the overshadowing-and-blocking account (Ellis, 2006), whereby salient cues dominate processing and hinder uptake of less salient but informative cues. In this context, entrenched L1 knowledge—specifically an agent-first bias—may have reduced attention to L2 grammatical features and sustained reliance on L1-informed routines. Viewed through the good-enough processing framework, these findings highlight how cue alignment and reweighting can shape L2 developmental trajectories.

Importantly, L1 influence was not absolute: learners showed limited, condition-specific sensitivity to L2 cues. By obscuring case-marking in Study 2, we tested whether learners would increase reliance on verbal morphology; nevertheless, agent-first responding remained dominant, implying that competition from case-marking was not the sole source of misanalysis and that reliance on the L1-based heuristic persisted. This contrasts with native speakers, who adjusted interpretation as a function of verb position (e.g., showing stronger theme-first responding when the verb appeared clause-initially), indicating that Korean affords processing advantages that proficient users can exploit. While learners largely failed to capitalise on these affordances—consistent with weak uptake of L2-specific routines—their agent-first preference was numerically reduced for passives relative to actives, suggesting a weak but non-zero influence of passive morphology. Eye-tracking likewise revealed brief, often late intervals in which gaze patterns aligned with passive-consistent role assignment; for example, in some verb-initial passives, learners appeared to use the early verbal cue to treat the first noun as theme rather than agent. These effects suggest not insensitivity to L2 cues *per se*, but rather fragile algorithmic parsing that is easily overridden by stronger heuristics.

Proficiency further moderated this processing profile. Higher-proficiency learners were more accurate on challenging constructions (e.g., scrambled actives and passives) and showed more target-aligned gaze behaviour than lower-proficiency peers. In Study 1, proficiency predicted better performance when sentences deviated from agent-before-theme order, suggesting that increased proficiency supported resistance to L1-based heuristics. Eye-tracking likewise indicated that more proficient learners shifted attention towards the correct referent more rapidly upon encountering diagnostic cues (e.g., verbs or case markers) and coped more effectively with passive-induced reanalysis. This pattern accords with evidence that proficiency, as a proxy for usage experience, supports deeper L2 processing (Hopp, 2017; Jackson, 2008) by strengthening structural representations and improving cue sensitivity. Proficiency did not eliminate shallow processing entirely—advanced learners remained vulnerable in the most complex configurations (e.g., doubly non-canonical passives)—but it was associated with gradual convergence on more target-like strategies, with increasing reliance on algorithmic routines when the input warranted them.

Overall, these findings suggest that L2 parsing strategies evolve through a shifting balance between heuristic and algorithmic streams. Early in development, comprehension is dominated by efficient heuristics, often reflecting transferred L1 biases; with increasing proficiency and experience, learners progressively integrate more grammar-driven routines and become better able to revise initial commitments. In this sense, L2 acquisition involves not only the acquisition of new representations but also the continuous recalibration of processing routes: heuristic and algorithmic streams are reshaped by experience, enabling learners to approach target-like comprehension while maintaining processing efficiency.

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