Passive Voice Is Still Difficult to Acquire: Korean Monolingual Children's Comprehension of Suffixal Passive Construction Through Webcam Eye-Tracking

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1. Introduction

Two competing accounts have been proposed to explain how children generalise grammatical knowledge. One account, *gradual abstraction*, maintains that generalisation is delayed until sufficient evidence is accumulated, as children's early knowledge is centred on specific lexical items and more abstract constructions emerge incrementally (Akhtar, 1999; Ambridge & Lieven, 2015; Childers & Tomasello, 2001; Dittmar et al., 2008; Matthews et al., 2007; Ninio, 1999; Theakston et al., 2015; Tomasello, 2003). The central claim is that learners are conservative in extending their knowledge to novel items. Initial linguistic representations are based on lexical frames containing relatively stable, frequently encountered elements (e.g., verbs, pronouns, morphological markers) combined with flexible slots. These lexically specific schemas are assumed to function as stepping-stones, supporting the later emergence of more abstract representations. In its strongest formulation, this account proposes that abstract knowledge does not emerge until around the age of three (e.g., Tomasello, 1992). However, this claim has been challenged (e.g., Abbot-Smith et al., 2008; Pine et al., 1998), leading to a revised view in which, rather than being governed by strict age-related mechanisms, representational mastery is assumed to depend largely on linguistic exposure over extended periods.

By contrast, the *early abstraction* account proposes that children actively exploit current input to rapidly form abstract linguistic knowledge, acquiring both item-based frames and abstract representations early in development (Bencini & Valian, 2008; Brusini et al., 2016; Fisher, 1996; Marcus et al., 1999; Messenger & Fisher, 2018; Özge et al., 2019; Saffran et al., 1996). The strong version of this account argues that, by two to three years of age, children already possess abstract structural representations independent of input properties, guided by innate mechanisms for constructing such representations (e.g., Franck et al., 2011; Gertner et al., 2006; Lidz et al., 2003; Zhu et al., 2021). The moderate version, however, recognises early development of word- and sentence-level representations but contends that their integration relies on usage experience (e.g.,

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 Proceedings of the 50th annual Boston University Conference on Language Development, ed. Romi Hill et al., 750-763. Somerville, MA: Cascadilla Press.

Dąbrowska & Tomasello, 2008; Garcia et al., 2021; Rowland et al., 2012; Smolík, 2015). Accordingly, children's demonstrations of abstract knowledge do not necessarily indicate immediate or complete mastery, and substantial linguistic exposure remains essential for full consolidation.

Although extensive evidence supports both accounts in major (Indo-European) languages, relatively little research has examined their applicability to learners of typologically distinct languages. Studies on Czech (Smolík, 2015), Tagalog (Garcia et al., 2021), and Turkish (Özge et al., 2019) provide support for early abstraction, yet differ in their conclusions regarding the degree of abstraction achieved and the role of language exposure in generalisation. Consequently, research extending beyond major languages remains limited, raising questions about the extent to which developmental patterns observed in these languages can be generalised to learners of other linguistic systems.

1.1. Suffixal Passive Constructions in Korean

This study investigates Korean, a language that has received comparatively little attention in this line of research. Korean follows a Subject–Object–Verb word order and employs overt case-marking, realised through dedicated particles, as well as affixation to encode grammatical information. These structural properties allow constituent scrambling, provided that reordering preserves meaning and avoids ambiguity. In addition, Korean permits the omission of most sentential elements when the missing information is recoverable from context.

Specifically, we examine a passive construction, a major clausal device for expressing transitive events (though infrequently used) that is widely recognised as difficult for children to acquire (Borer & Wexler, 1987; Brooks & Tomasello, 1999; Huang et al., 2013; de Villiers & de Villiers, 1973; cf. Deen, 2011). Eye-tracking studies have shown that English-speaking children parse passive sentences in ways that vary with age and language proficiency, alongside asymmetric performance across task types (Abbot-Smith et al., 2017; Messenger & Fisher, 2018).

Although the passive voice is morphologically marked across many languages (Haspelmath, 1990; Siewierska, 2013), its frequency in Korean is notably low relative to the active voice (Park, 2021; Shin & Mun, 2023; Woo, 1997). Of the three Korean passive types—lexical, suffixal, and periphrastic (Sohn, 1999)—the suffixal passive occurs most frequently in caregiver input (Shin & Deen, 2023) and therefore constitutes the primary passive form encountered by children.

The suffixal passive features a nominative-marked theme, a dative-marked agent, and passive verbal morphology (PSV) (Table 1).[1] PSV, a defining feature

[1] Abbreviation: ACC = accusative case marker; CASE = case marker (unspecified); DAT = dative marker; DCL = predicate ending, declarative; NOM = nominative case marker; PL = predicate ending, polite; PST = past tense marker; PSV = passive suffix; strikethrough = obscured.

of this construction, requires revising initial associations between thematic roles and case markers (agent–nominative + recipient–dative → theme–nominative + agent–dative). This revision gives rise to (i) competition between the *Theme-First* heuristic (first NP = theme) and the *Agent-First* strategy typical of the active voice (cf. Sinclair & Bronckart, 1972; see Shin, 2021 for a detailed discussion of this strategy in Korean monolingual children's sentence comprehension), and (ii) competition between the *Nominative-as-Theme* (N–NOM = theme) and *Dative-as-Agent* (N–DAT = agent) heuristics and the agent-nominative and theme-accusative mappings characteristic of active constructions (cf. Shin & Mun, 2023).

Table 1. Active transitive and suffixal passive constructions in Korean (canonical word order)

Type	Active transitive	Suffixal passive
Example	Ciwu-ka Mia-lul Ciwu-NOM Mia-ACC cap-ess-ta. catch-PST-DCL 'Ciwu caught Mia.'	Ciwu-ka Mia-hanthey Ciwu-NOM Mia-DAT cap-hi-ess-ta. catch-PSV-PST-DCL 'Ciwu was caught by Mia.'
Thematic role ordering	agent–theme	theme–agent
Case-marking	Typical (agent-NOM; theme-ACC)	Atypical (theme-NOM; agent-DAT)
Verbal morphology	No	Yes (*-i/hi/li/ki-*)

Shin (2022), the foundational study for the present research, examined Korean monolingual children's comprehension of the suffixal passive using four picture-selection experiments that incorporated a novel masking technique, whereby portions of test sentences were systematically obscured with acoustic sounds (e.g., coughs, chewing). In each experiment, participants viewed two pictures depicting the same transitive event with reversed thematic roles (e.g., a dog kicking a cat vs. a cat kicking a dog). After hearing each sentence twice, three participant groups—three- and four-year-olds, five- and six-year-olds, and adults—selected the picture that matched the sentence. The experiments yielded three key findings. First, due to competition between passive-voice knowledge, cued by verbal morphology, and more frequent, entrenched active-voice knowledge, children's reliance on passive-voice information varied with age, taken as a proxy for language-use experience. Second, five- to six-year-olds were able to apply passive-voice knowledge, although its use declined as sentence-level computational demands increased (e.g., with greater argument complexity or reduced case marking). Third, three- to four-year-olds did not consistently interpret passive sentences as active. Collectively, these findings indicate that sensitivity to passive morphology emerges early, but full mastery develops later and depends on extensive usage experience, particularly in relation to interactions among multiple components of voice-related knowledge.

1.2. Current Study

We extend Shin (2022) to further examine Korean monolingual children's comprehension of the suffixal passive within the two theoretical accounts. To this end, the study employs a webcam eye-tracking method (*WebGazer.js*; Papoutsaki et al., 2016). This method has demonstrated reliability as an alternative to laboratory-based eye-trackers (Özsoy et al., 2023; Semmelmann & Weigelt, 2018; Slim & Hartsuiker, 2022).

2. Methods

Twenty-eight children aged three to six years[2] (M_{month} = 56, SD_{month} = 11) and 20 adult controls (in their 20s and 30s) participated in two picture-selection experiments. Participants were required to match aurally presented sentences to one of two images, using a visual-world paradigm combined with webcam eye-tracking on a portable laptop (Lenovo YOGA 7i, 14.8-inch, 1280 × 720 webcam resolution).

The animacy of arguments in the test stimuli was controlled by using animals, ensuring that each item was semantically reversible and preventing reliance on animacy cues for thematic role assignment. Sentences were recorded by a male native Korean speaker who was unaware of the experimental aims. Canonical–scrambled sentence pairs were matched for overall duration and pitch to minimise vocal variability that might affect comprehension. A 100-ms interval was inserted between words in each sentence. Prior to the experiment, all sentences, corresponding pictures, and recordings were normed by ten native Korean speakers for naturalness/felicity and intended event interpretation. No specific concerns regarding vocal variability were reported.

At the start of the experiment, a main character (a human figure displayed on the screen) greeted participants and requested help in learning Korean. Participants were instructed to listen to his utterances and select the matching picture by pressing large arrow keys while viewing the scene. A 12-point calibration session then followed, during which the character raised a hand at each point in random order. If participants failed to meet the calibration threshold (75%), the procedure was repeated until successful. A training session using three practice items unrelated to the test materials was subsequently conducted to familiarise participants with the task.

In the main session, two identically sized pictures were displayed on the left and right sides of the screen. In each trial, the picture pair depicted the same action with reversed thematic roles, and picture placement was counterbalanced within and across participants. Pictures appeared 2000 ms before sentence onset and

[2] We initially recruited 44 children but excluded 18 who failed to meet the calibration threshold or were unable to maintain task engagement. Given the modest final sample size, the remaining participants were analysed as a single cohort, and developmental milestones or trajectories were not examined in detail.

remained on the screen throughout sentence presentation and for 2000 ms afterwards. Each auditory stimulus was presented once via headphones. Eye movements were recorded from picture onset to offset (50-ms time bins). Eye-gaze data were excluded if rendered invalid by blinks, substantial head movements, or fixation within a 5% margin of each half of the screen (Figure 1).

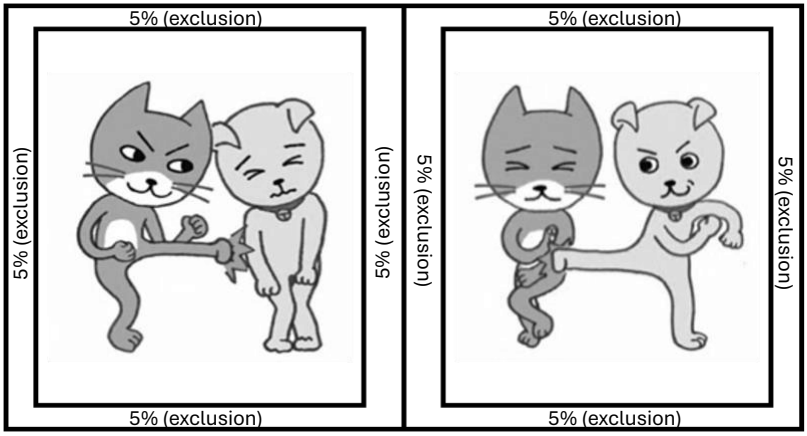


Figure 1. Illustration of 5 per cent margin from each half of the screen.

2.1. Experiment 1

Twenty-four test sentences were created by crossing voice type (active for fillers; passive for test items) and word-order type (canonical; scrambled), yielding six instances per condition, as illustrated in (1a–b) and (2a–b). Two sublists were constructed, and participants were randomly assigned to one of them. Stimulus sets were presented in a randomised order.

(1a) Canonical active transitive (filler): $N_{NOM}N_{ACC}V_{act}$
kangaci-ka koyangi-lul cha-yo.
dog-NOM cat-ACC kick-PL
'The dog kicks the cat.'

(1b) Scrambled active transitive (filler): $N_{ACC}N_{NOM}V_{act}$
koyangi-lul kangaci-ka cha-yo.
cat-ACC dog-NOM kick-PL
'The dog kicks the cat.'

(2a) Canonical suffixal passive: $N_{NOM}N_{DAT}V_{psv}$
kangaci-ka koyangi-hanthey cha-i-eyo.
dog-NOM cat-DAT kick-PSV-PL
'The dog is kicked by the cat.'

(2b) Scrambled suffixal passive: $N_{DAT}N_{NOM}V_{psv}$
koyangi-hanthey kangaci-ka cha-i-eyo.
cat-DAT dog-NOM kick-PSV-PL
'The dog is kicked by the cat.'

The $N_{NOM}N_{DAT}V_{psv}$ condition entails competition between entrenched active-voice knowledge (*Agent-First*; agent–NOM), which is frequent and typical, and passive-voice heuristics (*Theme-First*; *Nominative-as-Theme*; *Dative-as-Agent*), which are less frequent and are cued by verbal morphology. The $N_{DAT}N_{NOM}V_{psv}$ condition involves a similar competition, except with respect to word order (*Agent-First* vs *Theme-First*), as this condition begins with an agent-dative pairing that aligns with the *Agent-First* strategy.

Participants' responses were coded as 0 (incorrect) or 1 (correct). To compare mean accuracy across conditions and groups, the data were analysed using logistic mixed-effects models fitted with *lme4* (Bates et al., 2015) in R (R Core Team, 2024). *Group* (child, adult) and *Canonicity* (canonical; scrambled), per voice type, were entered as fixed effects (mean-centred and contrast-coded), with *Participant* and *Item* included as random effects. In addition to the global model, a separate model was fitted for child participants only, with *Canonicity* per voice type as the fixed effect structure and the same random-effects specification. All models incorporated the maximal random-effects structure permitted by the design (Barr et al., 2013). Model fit was assessed using Nakagawa's R^2 (specifically conditional R^2; Nakagawa et al., 2017).

Eye-gaze data were analysed using non-parametric permutation analyses (Abbot-Smith et al., 2017; Garcia et al., 2021). This approach generates a sampling (permutation) distribution through resampling of the observed data and is well suited to identifying processing effects in a data-driven manner. Specifically, it determines time points at which looks to the target diverge across word-order conditions for each voice type. The analysis proceeded in several steps. First, linear regression models were fitted to assess the effect of word order on target fixations for each 50-ms time bin, separately by voice type. The proportion of target fixations was calculated by dividing fixations to the target by the total number of fixations to the agent and patient. This yielded a series of time bins associated with significant *p*-values. Second, adjacent significant bins were clustered on the assumption that they reflect a single processing event. Finally, a permutation distribution was generated by randomly shuffling word-order labels within clusters and refitting the regression model to the permuted data. This procedure was repeated 1,000 times, producing a distribution of summed *t*-values for each cluster. Observed cluster statistics were then compared against this distribution to determine statistical significance.

2.2. Experiment 2

We devised a novel scenario in which the main character was hungry and eating food. Yum-yum sounds were strategically overlaid on the case markers,

thereby obscuring case-marking information. There were six instances per voice type (active for fillers; passive for test items), as illustrated in (3a–b), yielding 12 sentences in total. The same verbs as in Experiment 1 were used, combined with different animal pairings. All sentences were normed by ten adult native Korean speakers, who confirmed that the picture-supported sentences were interpreted as the intended transitive events with the target verbs. Two sublists were created, and participants were randomly assigned to one of them. Stimulus sets were presented in a randomised order.

(3a) Active transitive, no case marker (filler): $N_{\text{~~CASE~~}}N_{\text{~~CASE~~}}V_{act}$
kangaci-*yum-yum* koyangi-*yum-yum* cha-yo.
dog-~~CASE~~ cat-~~CASE~~ kick-PL
'The dog/cat kicks the cat/dog.'

(3b) Suffixal passive, no case marker: $N_{\text{~~CASE~~}}N_{\text{~~CASE~~}}V_{psv}$
kangaci-*yum-yum* koyangi-*yum-yum* cha-i-eyo.
dog-~~CASE~~ cat-~~CASE~~ kick-PSV-PL
'The dog/cat is kicked by the cat/dog.'

The $N_{\text{~~CASE~~}}N_{\text{~~CASE~~}}V_{psv}$ condition involves competition between frequent, canonical active-voice knowledge (*Agent-First*) and the less frequent passive-voice heuristic (*Theme-First*), cued by verbal morphology, given the computation of two arguments in thematic role assignment. Because the case markers indicating each argument's role were masked, responses in this condition were in principle ambiguous; scoring therefore reflected the high likelihood of an agent-first interpretation (0 = theme-first; 1 = agent-first). Statistical analyses of behavioural responses and eye-gaze patterns followed the same procedures as in Experiment 1.

3. Results

3.1. Picture selection

Figure 2 presents response rates for the two groups in Experiment 1. In the global model ($R^2 = 0.618$), only a main effect of Group was observed ($\beta = -4.200$, $SE = 0.678$, $z = -6.196$, $p < 0.001$), indicating a robust group difference in accuracy independent of Condition. Adults outperformed children across all conditions (adults: 100% in both active conditions, 95% in the canonical passive condition, 100% in the scrambled passive condition; children: 79% in the canonical active condition, 67% in the scrambled active condition, 45% in the canonical passive condition, and 59% in the scrambled passive condition). In the active conditions ($\alpha = 0.025$), the numerical difference in children's accuracy did not reach statistical significance ($p = 0.055$); however, accuracy increased with age (canonical: $t(76) = 3.452$, $p < 0.0001$; scrambled: $t(76) = 3.169$, $p < 0.002$). In the passive conditions ($\alpha = 0.025$), accuracy differences were not significant and showed no correlation with age.

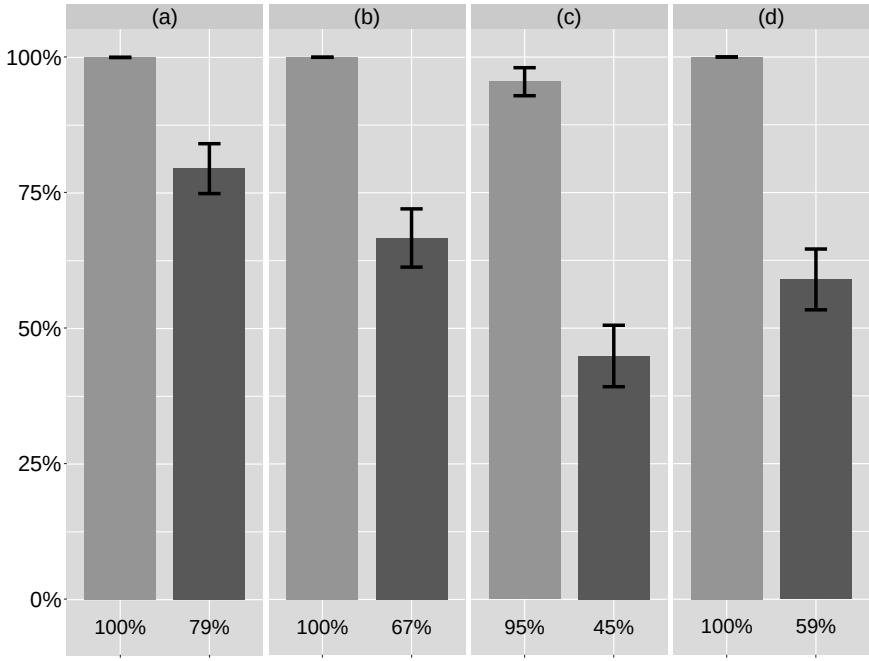


Figure 2. Results: Picture selection (Experiment 1). Light = Adult; Dark = Child. X-axis = Condition; y-axis = accuracy. (a) = $N_{NOM}N_{ACC}V_{act}$, (b) = $N_{ACC}N_{NOM}V_{act}$, (c) = $N_{NOM}N_{DAT}V_{psv}$, (d) = $N_{DAT}N_{NOM}V_{psv}$.

Figure 3 presents response rates for Experiment 2. In the global model (R^2 = 0.376), a significant main effect of *Group* was found (β = –2.539, *SE* = 0.291, z = –8.709, $p < 0.001$), reflecting higher accuracy in adults than in children across conditions (adults: 95% in the active condition, 92% in the passive condition; children: 68% and 51%, respectively). The mean rate of agent-first responses in the active condition exceeded chance, whereas theme-first responses in the passive condition did not; neither measure was correlated with age.

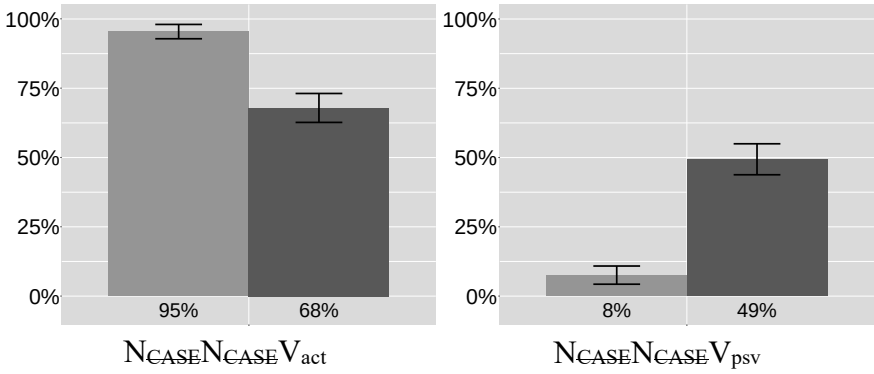
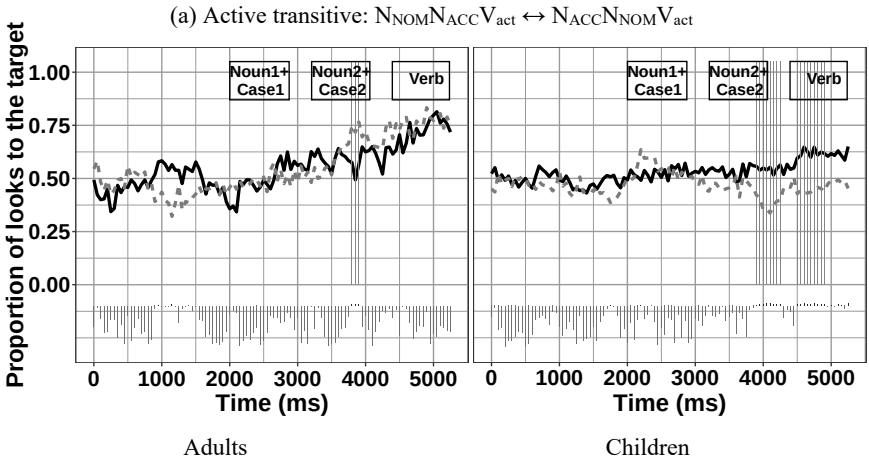


Figure 3. Results: Picture selection (Experiment 2). Light = Adult; Dark = Child. X-axis = Condition; y-axis = agent-first response rate.

3.2. Eye gaze

Figure 4 displays eye-movement patterns for both groups in Experiments 1 and 2. Sentence regions are indicated by rectangles. Bars below 0.00 represent linear regression *p*-values for each 50-ms bin (light: $p > 0.05$, non-significant; dark: $p < 0.05$, significant). Grey shading above 0.00 denotes significant clusters identified by permutation analysis.



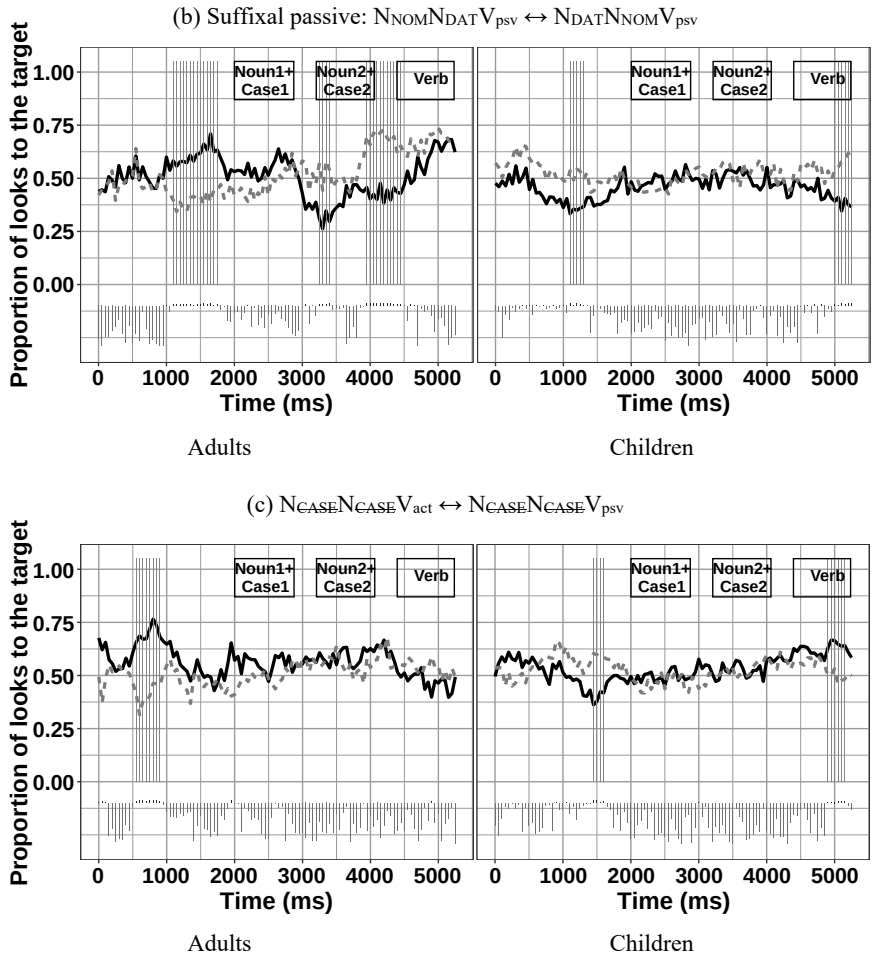


Figure 4. Results: Eye-tracking (average proportion of looks to the target from 2000 ms prior to a sentence onset until the end of a trial). Dark = (a,b) canonical, (c) active; Light = (a, b) scrambled, (c) passive.

In the case-marked active transitive conditions (a), children fixated more on the target events in the canonical condition (agent–NOM + theme–ACC) than in the scrambled condition (theme–ACC + agent–NOM) at later stages of NP2 processing (theme–ACC in the canonical condition; agent–NOM in the scrambled condition). This pattern suggests that the processing advantage for canonical thematic-role ordering in active transitives emerges relatively late during sentence comprehension.

In the case-marked suffixal passive conditions (b), children showed greater fixation on target events in the scrambled condition (agent–DAT + theme–NOM) than in the canonical condition (theme–NOM + agent–DAT) at the verb region. In

the case-less conditions (c), children fixated less on target events in the passive (theme-first) than in the active (agent-first) condition at the verb. Taken together, the results in (b) and (c) indicate that (i) children devoted extended attention to the two-picture displays and accompanying auditory input in these conditions, and (ii) their ultimate interpretations aligned more closely with the canonical agent–theme ordering characteristic of active transitives.

4. Discussion and Conclusion

The picture-selection results are broadly consistent with previous findings on children's difficulties in interpreting scrambling across languages (e.g., Kim et al., 2017; Schipke et al., 2012; Slobin & Bever, 1982). In particular, the observed degradation in children's performance on the suffixal passive replicates the results reported in Shin (2022). This pattern highlights the acquisitional challenges arising from competition between relatively weak passive-voice heuristics, cued by passive morphology, and more robust, entrenched active-voice knowledge, which frequently overrides passive interpretations.

The eye-gaze data further illuminate online processing dynamics, revealing substantial divergence in children's fixation patterns across experimental conditions. Within transitive events, processing was facilitated when word order and case-marking cues aligned with the canonical pattern—nominative-marked agent followed by accusative-marked theme—as shown in (a). By contrast, children experienced difficulty correctly mapping a nominative-marked theme and a dative-marked agent to the target picture, as observed in (b). This indicates persistent challenges with passive constructions, driven by the dominance of active-voice knowledge despite emerging sensitivity to passive morphology. Performance in (c), which directly isolates the contribution of passive morphology to comprehension, further confirms its comparatively weak influence in processing the suffixal passive. Taken together, and in light of the eye-gaze patterns in (a), the results from (b) and (c) suggest that children ultimately relied more on an agent-first, theme-second interpretation, reflecting the typical organisation of transitive events under competition between active-voice knowledge and passive-voice heuristics.

Interestingly, adults in the present study also appeared to benefit from canonical thematic-role ordering (i.e., agent-before-theme), as indicated by case markers contextualised by the pictures, when processing the suffixal passive, particularly at later stages of NP2. Although adult performance is not the primary focus here, this pattern further underscores the asymmetric strength of active-voice knowledge relative to passive-voice heuristics, even in mature sentence processing.

Overall, the findings indicate that children exhibit limited, though non-zero, reliance on passive-voice heuristics when comprehending the suffixal passive, largely due to competition from more robust active-voice knowledge. This pattern replicates Shin (2022) and aligns with previous work (Dąbrowska & Tomasello, 2008; Garcia et al., 2021; Rowland et al., 2012), thereby lending further support to moderate versions of both the gradual- and early-abstraction accounts.

Specifically, although abstract grammatical knowledge may emerge early, mastery of less frequent constructions—such as the suffixal passive examined here—requires extended exposure and usage-based learning.

Beyond elucidating the interaction between linguistic exposure, processing dynamics, and language development, the present study demonstrates the feasibility of applying webcam eye-tracking to under-explored languages. This has the potential to reduce sampling biases and methodological barriers, thereby contributing to more inclusive and accessible research practices in the field.

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Proceedings of the 50th annual Boston University Conference on Language Development

edited by Romi Hill, Xinhan Jiang, Danutham Worapipat, and Aditya Yedetore

Cascadilla Press Somerville, MA 2026

ISSN 1080-692X
ISBN 978-1-57473-047-0 (2 volume set, paperback)

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