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Research Paper

From 'Some' to 'Not All': Developmental Trajectories and Cognitive Correlates of Scalar Implicature Comprehension in Monolingual Persian-Speaking Children (Aged 4-7 Years)

Elaheh Kamari*
Assistant professor of Linguistics, Department of English Language Teaching, Farhangian University, Tehran, Iran
elaheh.kamari@cfu.ac.ir

Abstract
This study investigated the developmental trajectory of Scalar Implicature (SI) comprehension in monolingual Persian-speaking children, examining how linguistic typology, contextual support, and cognitive abilities influence this process in a Subject-Object-Verb language. 60 children divided into 2 age groups (4-5 and 6-7 years), along with 20 adults, participated in a Statement Evaluation Task involving the quantifier "some" ("ba'zi"). The task was designed to evaluate whether participants interpreted "some" as "some but not all" in scenarios where the alternative "all" is true with two contextual conditions: Basic and Enriched, the latter increasing the salience of the "all" alternative. Standardized assessments of Working Memory (WM) and Theory of Mind (ToM) were also administered to explore cognitive correlates. Results showed a significant main effect of Age Group; older children demonstrated higher SI rates (mean=0.61) than younger children (mean=0.35), indicating a developmental increase in pragmatic competence. Moreover, contextual enrichment significantly enhanced SI rates overall, with older children benefiting more notably as evidenced by a significant interaction between age and context. Correlational analyses revealed that WM capacity (Backward Digit Span) was associated with SI performance in the Basic Context, whereas ToM scores correlated with SI rates in the Enriched Context, suggesting dissociable cognitive mechanisms underpin SI comprehension depending on contextual complexity. These findings supported a universal developmental progression from logical to pragmatic interpretations of scalar terms in Persian-speaking children, emphasizing the roles of WM and ToM in the emergence of pragmatic inference. Overall, the study highlighted how contextual cues and cognitive resources differentially facilitate SI understanding, lending support to resource-dependent models of pragmatic development.
Keywords: Scalar Implicature (SI), Child Language Development, Persian, Cognitive Development, Theory of Mind (ToM), Working Memory (WM).

1. Introduction

The ability to comprehend not just what is explicitly stated, but also what is implicitly communicated, is a cornerstone of proficient language use. Scalar Implicatures (SIs) represent a key instance of such pragmatic inference. SIs arise when a speaker uses a less informative term from a scale of alternatives (e.g., <some, most, all>, <might, must>, <warm, hot>), leading the listener to infer that a stronger, more informative term on the scale does not apply (Horn, 1972; Geurts, 2010). For example, hearing "Some of the cookies are on the plate" typically leads adults to infer "Not all of the cookies are on the plate". This inference is thought to stem from the Gricean Maxim of Quantity, which enjoins speakers to be as informative as is required for the current purposes of the exchange. This maxim operates under the umbrella of Grice's Cooperative Principle, the assumption that participants in a conversation normally seek to be truthful, relevant, and clear (Grice, 1975). If the speaker knew that *all* cookies were on the plate, they would have said so; their use of "some" thus implies the negation of "all".

The acquisition of SIs has been a vibrant area of research in developmental psycholinguistics for over two decades (Noveck, 2001; Papafragou & Musolino, 2003; Guasti et al.; 2005; Pouscoulous et al. 2007). A seminal finding is that young children, typically before the age of 6 or 7, often interpret scalar terms like "some" logically (i.e., as "some and possibly

*Corresponding author

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all") rather than pragmatically (as "some but not all") (Noveck, 2001; Papafragou & Musolino, 2003; Chierchia et al., 2001). For instance, when presented with a scenario where all characters have completed an action (e.g., all three horses jumped over a fence) and asked if it is true that "Some of the horses jumped over the fence", young children frequently respond "yes", whereas adults are more likely to respond "no", judging the statement to be under-informative and therefore pragmatically infelicitous (Papafragou & Musolino, 2003). This phenomenon has been termed the "pragmatic delay" (Noveck, 2001; Bott & Noveck, 2004).

However, the nature and extent of this delay are subjects of ongoing debate. Some researchers argue that children lack the pragmatic competence to spontaneously derive SIs (Default-Ignorance accounts; Fox, 2014), while others suggest that children possess the core pragmatic ability but face difficulties due to task demands, processing limitations or an insufficient understanding of alternatives (Context-Driven/Constraint-Based accounts; Katsos & Bishop, 2011; Barner et al., 2011; Skordos & Papafragou, 2016). These constraint-based models posit that SI derivation is not an automatic, default process but rather an effortful inference that consumes cognitive resources (Degen & Tanenhaus, 2015). Indeed, numerous studies have demonstrated that children's rates of SI derivation can be significantly modulated by various factors. For example, providing more explicit contextual support, making the stronger alternative ('all') more salient, or using tasks that reduce cognitive load can lead to higher rates of pragmatic responses even in younger children (Guasti et al., 2005; Papafragou & Tantalou, 2004; Pouscoulous et al., 2007; Schidelko, & Rakoczy, 2025). Training studies have also shown that children can be taught to derive SIs more consistently (e.g., Papafragou & Musolino, 2003).

Beyond task manipulations, individual differences in children's cognitive capacities have been increasingly recognized as crucial moderators of SI acquisition. Deriving an SI is often considered a multi-step process: accessing the literal meaning, recognizing the scalar alternatives, retrieving contextual information, reasoning about the speaker's intentions, and inhibiting the literal interpretation in favor of the pragmatic one. These steps likely draw upon general cognitive resources (Antoniou & Katsos, 2017; Barner et al., 2011). Working Memory (WM), for instance, is crucial for temporarily storing the literal meaning, retrieving the stronger alternative ('all') from the lexicon, and manipulating these two representations to detect the pragmatic conflict (Andres-Roqueta & Katsos, 2017; Marty & Chemla, 2013). Executive functions, such as inhibitory control, may be needed to suppress the initial logical interpretation (Johann et al., 2022). Furthermore, Theory of Mind (ToM)—the ability to attribute mental states to others—is considered essential for reasoning about speaker intentions and why they choose a weaker term (Papafragou & Musolino, 2003; Hurewitz et al., 2006; Schaeken et al., 2018; Bensoussan et al., 2021). Recent research suggests that these cognitive factors not only correlate with SI abilities, but may also mediate the effects of age and task manipulations (Barner et al., 2011; Shetreet et al., 2014).

While the body of research on SI acquisition is substantial, it has predominantly focused on Indo-European languages like English (Sullivan et al., 2019), Italian (Foppolo et al., 2012), French (Noveck, 2001), and Greek (Papafragou & Tantalou, 2004). To establish the universality of developmental patterns and understand the potential influence of language-specific properties, investigations in typologically diverse languages are critical. Persian (Farsi), an Indo-Iranian language with a canonical SOV (Subject-Object-Verb) word order offers such an opportunity. While word order differences could potentially influence processing demands by altering the position of the quantifier relative to the verb phrase, a pre-verbal quantifier, for instance, might require the listener to hold the quantifier and its scope in WM for a longer duration until the verb is encountered, potentially increasing processing load compared to SVO languages (Faghiri & Samvelian, 2020). The Persian quantifier system itself includes terms like *ba'zi* ('some'), *aksar* ('most'), and *hame* ('all'), which form semantic scales analogous to their English counterparts (Karimi, 2005). This makes Persian an ideal test case for examining whether the developmental trajectory of SI comprehension is a universal phenomenon robust across different linguistic structures.

The existing literature on Persian child language has primarily focused on foundational areas, such as morphosyntax (e.g., Babanezhad & Rahmany, 2016) and phonology (e.g., Keshavarz & Ingram, 2002), with pragmatic development remaining a largely underexplored domain. While these studies provide a crucial understanding of structural language acquisition in Persian-speaking children, the nuanced area of how they learn to understand and use language in social contexts is less understood.

To our knowledge, the study by Khani et al. (2024) represented the sole investigation into a related aspect of pragmatic competence, showing that children from early childhood could understand and derive scalar implicatures. Their work also specifically examined the comprehension of simile and metaphor, revealing that children's reliance on literal interpretations decreased with age. While the work of Khani et al. (2024) is a pivotal first step in Persian, its focus on figurative language is distinct from the specific area of pragmatic competence investigated in the present study.

Therefore, this research aimed to broaden the very limited scope of pragmatic studies in Persian-speaking children by examining a different, unaddressed aspect of this competence. By doing so, this study provided crucial cross-linguistic data to test the robustness of existing theoretical models and developmental timelines in a previously unexamined linguistic context. The present study aimed to fill this gap by investigating the comprehension of scalar implicatures associated with the quantifier *ba'zi* ('some') in monolingual Persian-speaking children aged 4-7 years. Specifically, we sought to:

1. Establish the developmental trajectory of SI comprehension in this age range, comparing children's performance to that of adult native speakers.
2. Examine the impact of contextual enrichment designed to make the stronger scalar alternative ('all') more salient on children's SI derivation rates.

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3. Investigate the relationship between children's SI comprehension and their developing cognitive abilities, namely Working Memory (WM) and Theory of Mind (ToM).

Based on the existing cross-linguistic literature, we formulated the following hypotheses:

1. (H1) Developmental Progression in an SOV Context: To test the universality of developmental patterns in SI acquisition, we hypothesized a significant developmental progression in Persian. Despite the potential for increased processing load in an SOV language, where a pre-verbal quantifier must be held in WM until the verb is encountered, we expected older children (6-7 years) to derive SIs more frequently than younger children (4-5 years) and adults to do so most consistently. Observing this standard developmental trajectory in a typologically distinct language would strengthen the claim for a universal maturational pathway for pragmatic development.

2. (H2) Contextual Facilitation to Offset Processing Load: We hypothesized that contextual enrichment, which makes the scalar alternative 'all' more salient, will significantly increase SI derivation rates. This facilitative effect was predicted to be particularly crucial in an SOV language. The external contextual cues may serve to offset the heightened cognitive load associated with holding the quantifier and its alternatives in memory, thus making it easier for children to compute the pragmatic inference. The magnitude of this effect may interact with age as the ability to leverage such cues is itself a developing skill.

3. (H3) Cognitive Correlates, Emphasizing WM: We predicted that individual differences in WM and ToM would be positively correlated with SI derivation rates. Specifically, given the structural demands of Persian (SOV), we anticipated a particularly strong relationship between WM capacity and SI derivation. The need to maintain the quantifier's meaning over a longer duration until the sentence-final verb is processed should place higher demands on WM resources, especially in conditions with minimal contextual support. ToM was expected to correlate with performance when reasoning about speaker intention was facilitated by richer contextual cues.

By addressing these questions, this study provided the first systematic account of SI acquisition in Persian-speaking children, contributing to a broader understanding of pragmatic development. The findings will inform theoretical debates about the nature of children's early pragmatic abilities and the factors that constrain or facilitate their expression. Methodologically, it will contribute to refining tasks for assessing pragmatic skills in diverse linguistic populations. Practically, it may offer insights for language education and identification of pragmatic difficulties in Persian-speaking children.

2. Materials & Methods

This study utilized an experimental mixed-design to investigate the comprehension of SI. The primary task involved a 2 (Age Group: Younger [4-5 years] vs. Older [6-7 years]) × 2 (Context: Basic vs. Enriched) structure, with Age Group serving as a between-subjects factor and Context as a within-subjects factor. The primary dependent variable was the rate of pragmatic interpretations in under-informative 'some' scenarios. Additionally, individual differences in WM and ToM were assessed and treated as continuous predictor variables in subsequent analyses. An adult control group was also tested to establish a baseline for mature performance.

ToM was evaluated based on children's performance on classic false-belief paradigms, specifically the Unexpected Contents task (Perner et al., 1987) for all children and the more advanced Second-Order False Belief task (Perner & Wimmer, 1985) for the older group and adults. The basis for this evaluation was to operationalize ToM as the core ability to attribute a mental representation (a belief) to another person that is understood to be distinct from one's own knowledge and from reality itself. This specific form of mentalistic reasoning is considered a direct prerequisite for the inferential process required in scalar implicature comprehension. In particular, it is the cognitive mechanism that allows a listener to move beyond the literal meaning of an utterance to question *why* a speaker chose a less informative term (e.g., 'some') when a more informative one ('all') was available and relevant. By using these standardized tasks, we obtained a direct measure of the cognitive skill we hypothesized to be a key predictor of performance, especially in our Enriched Context, where the experimental design explicitly highlighted the speaker's choice and thus placed a high premium on reasoning about their communicative intentions

A total of 80 participants were recruited for the study. The child sample comprised 60 monolingual Persian-speaking children from preschools and elementary schools in Tehran, Iran, who were divided into two groups: a Younger Group (YG) of 30 children (16 female, M_age=4 years, 7 months; SD=4.2 months) and an Older Group (OG) of 30 children (14 female, M_age=6 years, 6 months; SD=4.5 months). According to parental reports, all children were acquiring Persian as their sole first language, had no history of significant developmental, speech, language, or hearing impairments, and possessed normal or corrected-to-normal vision. Socioeconomic status was predominantly middle to upper-middle class. All children passed the perceptual subtests of the Vocabulary and Perception Test (NematZadeh et al., 2008) with scores within 1.5 standard deviations of the age-appropriate mean (M=104.7, SD=8.9), confirming typical development. The Adult Control Group (AG) consisted of 20 native Persian-speaking undergraduate or graduate students (11 female, M_age=23 years, 8 months; SD=2 years, 3 months) from Tehran University, who reported no history of language or neurological disorders. Written informed consent was obtained from all adult participants and the legal guardians of child participants, while children provided verbal assent. Participants were informed of the voluntary nature of their involvement and their right to withdraw at any time.

The main instrument was a Statement Evaluation Task designed to measure SI comprehension. This task consisted of

16 critical experimental items. Each participant viewed 8 items in the Basic Context and 8 items in the Enriched Context, with the specific stories counterbalanced across conditions and participants. In the Basic Context, the puppet simply made the "some" statement. In the Enriched Context, the 'all' alternative was made more salient primarily through an explicit exchange between two puppets. For instance, in a typical enriched trial, a second puppet (e.g., "Bashi") would first observe the outcome and ask the speaker-puppet (Pishi), 'Did all the mice eat cheese?' (*Aya hame-ye moosh-hā panir khordan?*). This exchange served to explicitly raise the 'all' alternative into the set of potential utterances, making the subsequent use of 'some' by Pishi a more noticeable and pragmatically marked choice: 'Hmm, let me see... some of the mice ate cheese.' The critical 'all' outcome remained the same, but the 'all' alternative was made explicitly relevant to the Question Under Discussion (QUD)". In addition to the experimental items, the task included control items to ensure comprehension, including 8 "some-but-not-all" trials (expected response: "true"), 8 "none" trials (expected response: "false"), and 16 other filler items. The presentation order of all trials was pseudo-randomized. To assess cognitive correlates, a battery of standardized tasks was administered. WM was measured using the Auditory Digit Span-Persian (Mahdavi et al., 2017), which assessed both forward and backward spans and the computerized Corsi Block-Tapping Task (Claessen et al., 2014) for visual-spatial WM.

All participants were tested individually in a quiet room by a native Persian-speaking experimenter. The administration order of the SI task and the cognitive battery (WM and ToM tasks) was counterbalanced across participants within each age group. During the SI task, children were instructed to judge the puppet's statements as "right" (*dorost mige*) or "not right/wrong" (*dorost nemige / eshtebāh mige*) with visual aids (a smiley and a frowny face card) available for younger children. Two practice trials with feedback were provided to ensure understanding, but no feedback was given during the experimental or control trials. Cognitive tasks were administered according to their standardized protocols with breaks provided as needed. The entire session, which lasted approximately 35-50 minutes for children and 25-30 minutes for adults, was video-recorded for later reliability coding.

For the critical under-informative "some" trials, a "false" or "not right" judgment was coded as a pragmatic response (1), while a "true" or "right" judgment was coded as a logical response (0). All participants achieved over 75% accuracy on control items, so none were excluded. WM scores were the maximum span correctly recalled and ToM scores were based on correct/incorrect responses to belief questions. A second independent coder blind to the study's hypotheses analyzed 20% of the SI task responses, yielding excellent inter-rater reliability (Cohen's Kappa=0.97). All data were analyzed using R (Version 4.2.3). The primary analysis of SI derivation rates employed a Generalized Linear Mixed-effects Model (GLMM) with a binomial link function, using the lme4 package. The model included Age Group, Context, and their interaction as fixed effects, with random intercepts for Participants and Items and random slopes for the by-participant effect of Context. Age group differences on cognitive tasks were assessed with ANOVAs or t-tests and the relationships between SI rates and cognitive scores were examined using Pearson correlations. Significance for all fixed effects was determined using Wald χ^2 tests with an alpha level of .05 and the appropriate effect sizes were reported.

3. Results

3.1 Preliminary Analyses

All participants performed well on the control items of the SI task. Mean accuracy on "some-but-not-all" trials was 94.2% (SD=5.1%) for younger children, 97.5% (SD=3.8%) for older children, and 99.1% (SD=2.0%) for adults. Mean accuracy on "none" trials (where "some" was false) was 91.8% (SD=6.5%) for younger children, 96.3% (SD=4.2%) for older children, and 98.8% (SD=2.5%) for adults. Performance on other filler items was similarly high (all group means>90%). This indicated that participants understood the task requirements and the basic semantics of *ba'zi* ('some'). Adult participants consistently derived SIs in under-informative "some" conditions (M=0.93, SE=0.02), serving as a baseline for mature pragmatic performance. Due to their near-ceiling performance, adult data were excluded from the main GLMM focusing on child development but presented in figures for comparison.

3.2 Scalar Implicature Derivation Rates

The primary analysis involved a GLMM predicting the likelihood of a pragmatic response (SI derivation) with Age Group (YG, OG) and Context (Basic, Enriched) as fixed effects and their interaction. Random intercepts for Participants and Items were included.

The GLMM revealed a significant main effect of Age Group (χ^2 (1)=25.89, p<.001). Older children (M SI rate=0.61, SE=0.04) were significantly more likely to derive SIs compared to younger children (M SI rate=0.35, SE=0.04). This supported H1. There was also a significant main effect of Context (χ^2 (1)=11.23, p<.001). Participants were more likely to derive SIs in the Enriched Context (M=0.55, SE=0.03) compared to the Basic Context (M=0.41, SE=0.03). Crucially, these main effects were qualified by a significant Age Group × Context interaction (χ^2 (1)=4.12, p=.042). Post-hoc comparisons (Tukey-adjusted) exploring this interaction indicated:

A) For Younger Children (4-5 years), there was a trend towards higher SI rates in the Enriched Context (M=0.40, SE=0.05) compared to the Basic Context (M=0.30, SE=0.05), but this difference did not reach statistical significance (z=1.85, p=.064).

B) For Older Children (6-7 years), SI rates were significantly higher in the Enriched Context (M=0.70, SE=0.05) compared to the Basic Context (M=0.52, SE=0.06; z=3.08, p=.002). This interaction pattern suggested that while contextual enrichment generally aided SI derivation, its impact was more pronounced and statistically robust in the older

children group. This partially supported H2. Mean SI derivation rates are presented in Table 1 and Figure 1.

Table 1- Mean Scalar Implicature (SI) Derivation Rates (Proportion of Pragmatic Responses) and Standard Errors (SE) by Age Group and Context.

Age Group	Context	Mean SI Rate	SE
(4-5 yrs)	Basic	0.30	0.05
(4-5 yrs)	Enriched	0.40	0.05
(4-5 yrs)	Overall	0.35	0.04
(6-7 yrs)	Basic	0.52	0.06
(6-7 yrs)	Enriched	0.70	0.05
(6-7 yrs)	Overall	0.61	0.04
Adults	Basic	0.90	0.03
Adults	Enriched	0.96	0.02
Adults	Overall	0.93	0.02

Table 1 displays the mean proportion of pragmatic responses (SI derivations) and Standard Errors (SE) for the quantifier "some" (*ba'zi*) in under-informative contexts broken down by Age Group (Younger, Older, Adults) and Context (Basic, Enriched).

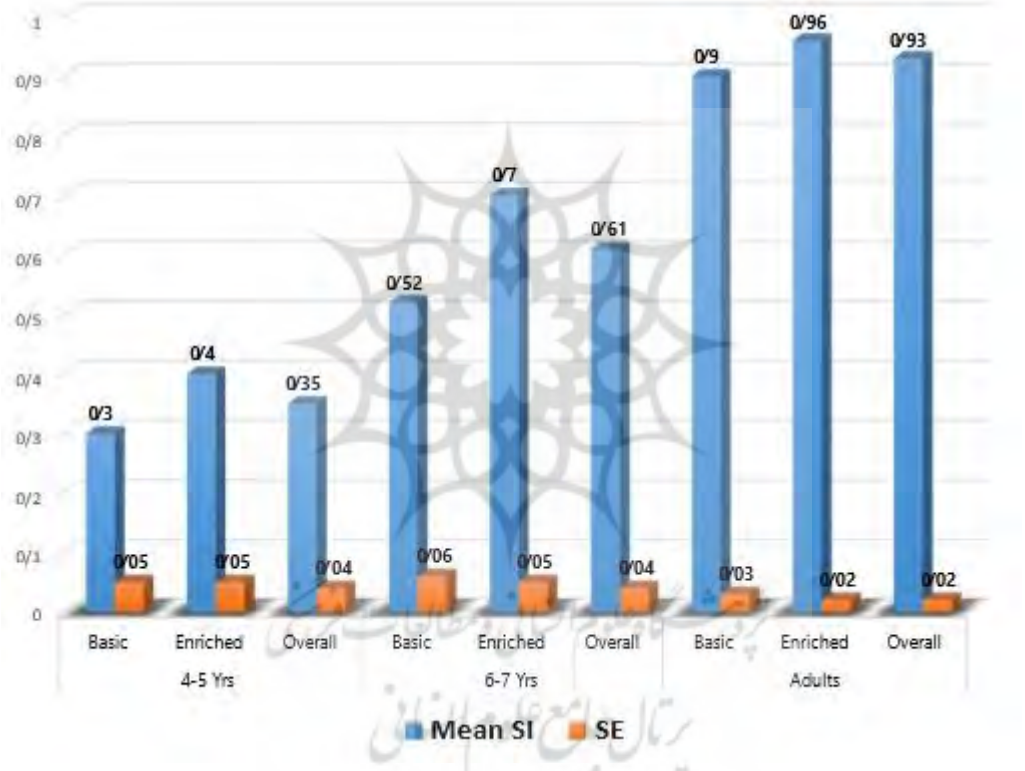

Figure 1- Mean Scalar Implicature (SI) Derivation Rates by Age Group and Context.

Mean SI derivation rates (±SEM) for Younger Children (4-5 years), Older Children (6-7 years), and Adults by Context (Basic vs. Enriched) are presented in Figure 1. This figure illustrates the main effects of Age Group and Context and their interaction. Significant differences (e.g., *p<.05, **p<.01) are noted.

3.3 Cognitive Correlates of SI Derivation

3.3.1 Cognitive Task Performance: As expected, older children significantly outperformed younger children on all WM and ToM measures (all p's<.001). Mean scores are presented in Table 2.

Table 2- Mean Scores (and Standard Deviations) on Cognitive Tasks by Child Age Group.

Cognitive Task	(4-5 yrs) M (SD)	(6-7 yrs) M (SD)	Statistic (t/χ^2)	p-value
Digit Span Forward (DSF)	3.8 (0.7)	5.1 (0.8)	t (58) = -7.12	<.001
Digit Span Backward (DSB)	2.1 (0.6)	3.5 (0.7)	t (58) = -8.98	<.001
Corsi Block Span	3.5 (0.5)	4.8 (0.6)	t (58) = -9.25	<.001
ToM Score (0-1 or 0-2)	0.5 (0.5) (max 1)	1.4 (0.6) (max 2)	U = 120.5	<.001

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This table presents the mean scores and SD for WM (Digit Span Forward, Digit Span Backward, Corsi Block Span) and ToM tasks for the Younger (4-5 years) and Older (6-7 years) child groups, along with statistics for group comparisons.

3.3.2 Correlations with SI Rates: Pearson correlations were calculated between overall SI rates (and SI rates in Basic/Enriched contexts separately) and scores on the cognitive tasks for each child age group (Table 3).

Table 3- Pearson Correlations (r) between SI Derivation Rates and Cognitive Scores by Child Age Group

Cognitive Measure	Age Group	SI Rate (Overall)	SI Rate (Basic Context)	SI Rate (Enriched Context).
Digit Span Forward	(4-5 yrs)	.28	.21	.30
	(6-7 yrs)	.35	.31	.37*
Digit Span Backward	(4-5 yrs)	.34*	.30	.36*
	(6-7 yrs)	.45**	.48**	.40*
Corsi Block Span	(4-5 yrs)	.25	.19	.28
	(6-7 yrs)	.38*	.33	.41*
ToM Score	(4-5 yrs)	.32	.29	.35*
	(6-7 yrs)	.43**	.36*	.42**

*p < .05, **p < .01

This table shows Pearson correlation coefficients (r) between overall scalar implicature (SI) derivation rates (SI rates in Basic and Enriched contexts) and scores on cognitive measures (Digit Span Forward, Digit Span Backward, Corsi Block Span, Theory of Mind Score) for the Younger (4-5 years) and Older (6-7 years) child groups. Significant correlations are marked. Significant positive correlations emerged, particularly for the older children. For the Older Group (6-7 years):

A) Backward Digit Span (a measure of WM updating and manipulation) showed a strong positive correlation with SI rates in the Basic Context (r=.48, p=.007) and Overall SI rates (r=.45, p=.012).

B) ToM scores correlated significantly with SI rates in the Enriched Context (r=.42, p=.020) and Overall SI rates (r=.43, p=.017).

For the Younger Group (4-5 years):

C) Backward Digit Span showed a significant correlation with SI rates in the Enriched Context (r=.36, p=.049) and Overall SI rates (r=.34, p=.06, trend).

D) ToM scores correlated significantly with SI rates in the Enriched Context (r=.35, p=.050). These results partially supported H3, indicating that higher WM and ToM abilities were associated with more frequent SI derivation, with some specificity depending on age and context.

Regression Analysis (Exploratory for Older Children):

E) Given the stronger correlations, an exploratory multiple regression was conducted for the Older Children group predicting Overall SI Rate from DSB and ToM scores. Both DSB (β=.35, t=2.39, p=.023) and ToM (β=.31, t=2.11, p=.043) emerged as significant unique predictors, with the model explaining a significant portion of the variance (Adjusted R^2=.28, F (2, 27) = 6.78, p=.004).

3.4 Summary of Results Supporting Hypotheses

- ***H1 (Developmental Progression):*** Confirmed. Older children derived SIs significantly more often than younger children.
- ***H2 (Contextual Facilitation):*** Partially confirmed. Enriched context significantly improved SI rates overall. The interaction showed this benefit was statistically robust primarily for the older children though younger children showed a positive trend.
- ***H3 (Cognitive Correlates):*** Supported. Higher WM and ToM scores were associated with higher SI rates, particularly for older children. Specific relationships emerged: WM seemed more critical in basic, potentially more demanding contexts, while ToM was linked to performance when contextual cues about alternatives were richer.

4. Discussion

This study aimed to investigate the comprehension of scalar implicatures (SIs) in monolingual Persian-speaking children aged 4-7 years. Our findings provided the first systematic evidence on this topic in Persian, revealing a clear developmental trajectory, a strong influence of contextual support, and a critical link to developing cognitive abilities. We will discuss these findings in relation to our hypotheses and their broader implications.

4.1 Developmental Trajectory and Cross-Linguistic Universality

Consistent with H1 and a vast body of literature from predominantly SVO languages (e.g., Noveck, 2001; Papafragou & Musolino, 2003), our results showed a clear developmental progression. Older children (6-7 years) were significantly more likely to compute the pragmatic interpretation of "ba'zi" ('some') compared to their younger peers (4-5 years), who showed a stronger preference for the logical interpretation.

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The key contribution here was that this well-documented 'pragmatic delay' and subsequent development was robustly observed in Persian, a language with a head-final SOV structure that was theorized to impose greater processing demands (Faghiri & Samvelian, 2020). The fact that the developmental timeline was comparable to that found in SVO languages lends valuable support to the hypothesis of a universal developmental pathway for SI acquisition. It strongly suggests that the core challenges children face in deriving SIs are not rooted in language-specific structural properties, but rather in more fundamental cognitive and pragmatic maturation processes.

4.2 The Impact of Contextual Enrichment and Its Interaction with Age

In line with H2, our findings showed that contextual enrichment, making the stronger alternative 'all' more salient, significantly increased SI derivation rates overall. To isolate the influence of context, it is instructive to consider what the results would look like if the variable of age were not taken into account. If we were to collapse the data from both child groups, our analysis still revealed a significant main effect of context: children, as a whole, derived significantly more SIs in the Enriched condition than in the Basic one. This confirmed that contextual manipulation was a powerful factor in its own right, likely serving to reduce the overall processing cost of the inference (Guasti et al., 2005; Skordos & Papafragou, 2016).

However, this "age-blind" perspective masked the more critical insight revealed by the significant age-by-context interaction. The facilitative effect of context was statistically robust only for the older children. While younger children showed a positive trend, they did not benefit from the contextual manipulation to the same degree. This interaction demonstrated that the "utility" of contextual enrichment was not uniform across development. Older children equipped with more mature cognitive resources were far more adept at leveraging the salient 'all' alternative to guide their pragmatic reasoning. Younger children, by contrast, might require even more explicit or less complex contextual support to consistently overcome their default logical interpretations. This suggests that the ability to effectively utilize contextual cues is itself a skill that matures with age, acting as a crucial moderator that determines how effectively a child can resolve pragmatic ambiguity.

4.3 Cognitive Underpinnings: The Dissociable Roles of WM and ToM

Our most nuanced findings concerned the cognitive correlates of SI comprehension, strongly supporting H3. We found that higher WM and ToM scores were associated with more frequent SI derivation, but their influence was context-dependent, particularly for the older children. Working memory, specifically the Backward Digit Span, which tapped into both storage and manipulation, was the strongest predictor of SI rates in the Basic Context. This result was particularly telling in an SOV language like Persian. In a minimally supportive context, the child must carry a significant internal processing load: holding the literal meaning of the pre-verbal quantifier 'some' in memory, independently accessing the stronger alternative ('all'), comparing the two, and inhibiting the prepotent "true" logical response until the verb is encountered. This mental juggling act potentially exacerbated by the SOV word order places a heavy load on executive resources. This explains why children with higher WM capacity, who were better equipped to manage this internal load, performed better (Andres-Roqueta & Katsos, 2017; Marty & Chemla, 2013).

In contrast, "Theory of Mind" was the key predictor of performance in the Enriched Context. Here, the experimental manipulation (the second puppet's question about 'all') explicitly raised the Question Under Discussion (QUD). This external cue reduced the WM load associated with generating the alternative, freeing up cognitive resources. The child's primary task then shifted to reasoning about "why" the speaker (Pishi) chose the weaker term 'some' when the stronger term 'all' was made highly relevant. This process of mentalistic reasoning-attributing intentions to the speaker-is the hallmark of ToM (Papafragou & Musolino, 2003; Bensoussan et al., 2021). This dissociation suggests that WM and ToM contribute to distinct computational steps in the SI derivation process. In contexts with minimal support, derivation relies heavily on domain-general executive resources (WM) to manage the cognitive load. When the context reduces this load, domain-specific pragmatic reasoning (ToM) about the speaker's intentions can take precedence.

4.4 Theoretical and Practical Implications

These findings collectively lend strong support to resource-dependent, constraint-based models of pragmatic processing (e.g., Degen & Tanenhaus, 2015; Sperber & Wilson, 1995) and challenge simpler default-based accounts, which posit that SIs are generated automatically unless explicitly canceled by the context (e.g., Levinson, 2000; Chierchia, 2004). The clear developmental progression, significant effect of contextual support, and robust correlations with WM and ToM all indicate that, at least in childhood, SI derivation is an effortful, resource-intensive process rather than an automatic one. The "pragmatic delay" observed in Persian children is therefore best understood not as an absolute lack of competence, but as a performance limitation that is gradually overcome as foundational cognitive skills mature. Practically, our study underscored the importance of considering individual differences in cognitive development when assessing pragmatic abilities. Children with stronger WM and ToM were likely to be more adept pragmatic reasoners. For clinical and educational purposes, difficulties in pragmatic understanding in Persian-speaking children might be linked not only to core linguistic deficits, but also to limitations in domain-general cognitive capacities. This suggested that interventions targeting these underlying skills—for instance, through multi-step instruction games (for WM) or perspective-taking in storytelling (for ToM)—could have cascading benefits for pragmatic competence (Pijnacker et al., 2009).

4.6 Limitations and Future Directions

While providing novel insights into SI acquisition in Persian, this study had several limitations that pave the way for future research. First, the study was cross-sectional. Longitudinal research tracking individual children's development of SI comprehension alongside their cognitive growth would provide a more nuanced understanding of the causal relationships and developmental trajectories. Second, we focused on a single scalar quantifier (*ba'zi* 'some'). Future studies should examine other scalar terms in Persian (e.g., modals like *mumkene* 'possible' vs. *hatman* 'must') to assess the generality of the findings. Third, our contextual manipulation was effective but broad. Future research can explore the impact of more fine-grained contextual variations, such as the speaker's established epistemic state. Fourth, while we used standardized WM and ToM tasks, future work can incorporate a wider battery of executive function measures (e.g., inhibitory control, cognitive flexibility) to disentangle their specific roles more precisely. Finally, our study focused on comprehension. Investigating children's production of SIs in Persian can offer a complementary perspective.

5. Conclusion

This study offered the first systematic investigation of scalar implicature comprehension in monolingual Persian-speaking children, providing crucial data from a typologically distinct, SOV language. We demonstrated a clear developmental increase in children's ability to derive pragmatic interpretations of the quantifier "ba'zi" ('some'), supporting a universal developmental trajectory. This development was significantly modulated by the richness of the communicative context, with enriched contexts facilitating more pragmatic responses, particularly for older children, who could better leverage the cues.

Furthermore, individual differences in Working Memory (WM) and Theory of Mind (ToM) were found to be significant predictors of children's SI derivation rates. Our findings revealed a critical dissociation: WM was pivotal for the internally-driven computation in minimal contexts, a finding especially relevant given the potential processing demands of an SOV structure, while ToM was key to the intention-reading process in socially rich contexts. Collectively, these findings underscored the crucial role of emerging cognitive capacities in supporting pragmatic development and lent strong support to resource-dependent models of pragmatic inference over default-based accounts.

This research contributes to a cross-linguistically broader understanding of how children learn to navigate utterance interpretation beyond literal meaning, highlighting that mastering scalar implicatures is a gradual, effortful process. It is shaped by an intricate interplay of linguistic input, contextual cues, and maturation of foundational cognitive skills. Our work thus lays a firm foundation for further exploration of pragmatic development in Persian and other understudied languages.

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