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Featural Relativized Minimality in silence: The acquisition of sluicing in Italian

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This paper investigates the acquisition of elliptical indirect wh-questions, i.e. sluicing, by Italian preschool children. The goal is to determine whether children's comprehension of subject- and object-extracted sluices is also modulated by the locality principle of featural Relativized Minimality (fRM; Rizzi 2004; 2018) as is the case with lexicalized wh-questions. Adopting Merchant's (2001) structural approach to ellipsis, we designed three related experiments. Experiment 1 compares the comprehension of lexicalized and sluiced indirect wh-questions, aiming at verifying the presence of the subject>object asymmetry well-documented in the acquisition studies of other A′-dependencies. A subject advantage is detected in both elliptical and non-elliptical questions. To verify the role of fRM, Experiments 2 and 3 manipulate the degree of featural overlap between the wh-remnant and the other unpronounced DP in the sluice. We targeted Lexical Restriction (Experiment 2) and Number feature (Experiment 3). Our findings further confirm the subject>object asymmetry and, more crucially, demonstrate that children's difficulties with object sluices are alleviated when the subject and object are featurally mismatched, as predicted under fRM. We conclude that this locality principle regulates the acquisition of dependencies independently of their PF-realization. Our study further corroborates an analysis of sluicing in terms of full-fledged interrogative structures isomorphic to their antecedent (e.g., Merchant 2001).

1 Introduction

As well-known in the theoretical literature, syntactic dependencies are constrained by a uniform formal principle of locality, namely featural Relativized Minimality (fRM) (Rizzi 2004; 2018). According to the definition of fRM (1), locality effects arise when an element Z intervenes in the local relation between X and Y (1a), and shares relevant syntactic features with X (1b). Thus, fRM penalizes configurations involving intervention, according to their ranking on the distinctness hierarchy (1c).

(1) Featural Relativized Minimality
In … X … Z … Y … a local relation between X and Y is disrupted when
a. Z c-commands Y and Z does not c-command X (intervention configuration).
b. Z matches X in terms of Relevant Syntactic Features.
c. The degree of disruption is a function of the featural distinctness of X with respect to Z, in accordance with the distinctness hierarchy.

(Rizzi 2018: 347)

The distinctness hierarchy, represented in **Table 1**, is expressed as a grammar-based notion emerging from the set-theoretic relations that reflect the degree of similarity between X and Z. Crucially, only those syntactic features that participate in the licensing of syntactic positions are relevant for defining the dimension of similarity, and hence for the computation of locality.[1] (i) Disjunction represents the case of maximal distinctness, as X and Z do not share any relevant syntactic feature. Thus, no penalty arises. Conversely, (ii) identity constitutes the opposite pole of the hierarchy, i.e. when all relevant syntactic features are shared between X and Z, thereby leading to maximal penalty. (iii) Inclusion qualifies as an intermediate case of distinctness, as the relevant syntactic features specified on Z constitute a proper subset of those on X. Finally, (iv) intersection is ranked in between disjunction and inclusion: X and Z share some, but not all, relevant syntactic features, such that the featural specification of neither X nor Z is a subset of the other.[2,3]

The locality principle in (1) was initially conceptualized to capture weak-island effects in adult grammar, and later extended to child language acquisition to account for the difficulties

[1] According to Rizzi (2004; 2018), morphosyntactic features relevant for the computation of locality are grouped into feature classes, with locality effects arising within, but not across, these classes. The main classes include (i) Argumental features (NP, person, number, gender, case), (ii) Quantificational features (Wh-, Negation, Measure, Focus, etc.), (iii) Modifiers (evaluative, epistemic, manner, etc.), and (iv) Topic.

[2] We leave aside the distinction between criterial and non-criterial inclusion formalized in Rizzi (2018: 360), as it is not directly relevant to our argumentation.

[3] Throughout this paper, [+ NP] indicates lexical NP restriction feature, while [+ Q]/[+ R] denote the criterial features triggering movement in questions and relative clauses, respectively.

		X	…	Z	…	<Y>	Adult	Child
NO INTERVENTION		[+Q]				<[+Q]>	OK	OK
		Who	*has arrived*			<who>		
INTERVENTION	**Identity**	[+Q]		[+Q]		<[+Q]>	*	*
		What	*do you think*	*who*	*should bring*	<what>		
	Inclusion	[+Q, +NP]		[+Q]		<[+Q, +NP]>	??	*
		Which game	*do you think*	*who*	*should bring*	<which game>		
	Intersection	[+Q, +NP, +SG]		[+NP, +PL]		<[+Q, +NP, +SG]>	OK	??
		Which game	*do you think*	*the guests*	*should bring*	<which game>		
	Disjunction	[+Q]		[+NP, +PL]		<[+Q]>	OK	OK
		When	*do you think*	*the guests*	*should arrive*	<when>		

Table 1: fRM configurations and relative acceptability by adults and children.

experienced by young children with some A′-bar dependencies. In this field, a robust finding is the so-called subject > object asymmetry: while subject A′-extractions are produced and comprehended accurately, object A′-extractions represent a challenge for children. This result holds for a variety of syntactic structures across many languages, e.g., object-relative clauses (e.g., Friedmann & Novogrodsky 2004; Friedmann et al. 2009; Contemori & Belletti 2013), object wh-questions (e.g., De Vincenzi et al. 1999; Friedmann et al. 2009), left dislocated objects (e.g., Manetti & Belletti 2020). Under fRM (1), children's difficulties with object dependencies stem from the intervention of the subject DP in the chain of the moved object DP. Conversely, in subject dependencies no intervention effect arises, as the subject DP does not cross an object DP.

Interestingly, as expected under (1), it has also been demonstrated that locality effects can be ameliorated by modulating the featural overlap between the intervening subject (Z) and the moved object (X) according to the distinctness hierarchy (1c). Thus, a disjunction configuration is relatively unproblematic for children. For example, this configuration arises when an object relative clause contains an impersonal (third person plural) subject pronoun and a relativized full DP object [+NP] (Friedmann et al. 2009). An intersection configuration has been found to be more challenging than disjunction, but less so than an inclusion configuration. For example, children perform better when the subject and object of a relative clause are mismatched for the Number feature, such that the object is [+R, +NP, +SG] and the subject is [+NP, +PL], compared to when they are matched, e.g., both are [+SG] (Adani et al. 2010).

In this study, we focus on two features: Lexical Restriction and Number. Both of these features are claimed to be fRM-relevant features, i.e. features which define syntactic positions (1b): Lexical Restriction —that is, the presence or absence of a lexical overt noun phrase within the DP— is morpho-syntactically active in determining the landing site of wh-elements as well as of DPs, whereas Number is among the features that trigger the syntactic movement of

the subject from its vP-internal position to Spec,TP (e.g., Cardinaletti & Starke 1994; Cinque 1999; Rizzi 2018). Notably, these two features have received attention in previous studies addressing fRM in child grammar. For example, Friedmann et al. (2009) examined the role of Lexical Restriction mismatch by investigating the comprehension of object who- and which-questions in Hebrew-speaking children aged 3;7–4;10 using a sentence-picture matching task. They found that children struggled with which-object questions (inclusion configuration, 58%) and that their difficulties were significantly reduced with who-object questions (disjunction configuration, 75%). As expected, no such asymmetry emerged for subject wh-questions (which, 78% *vs*. who, 81%). Similarly, as previously mentioned, Adani et al. (2010) investigated the impact of number mismatch on the comprehension of Italian relative clauses, showing that Italian children comprehended object relative clauses more accurately in the Number mismatch condition (intersection configuration) than in the Number match condition (inclusion configuration). This difference was again not observed in the subject relative clauses. So far, the role of fRM in the acquisition of syntax has been mainly tested on A′-dependencies involving lexically-realized structures and manipulating features with morpho-phonological exponents. However, since fRM is a formal principle dealing with syntactic dependencies, it should be independent of lexicalization and therefore apply also to dependencies that are phonologically null.

The present paper contributes to previous research, verifying whether fRM and its related distinctness hierarchy regulate the acquisition of syntactic dependencies that do not receive lexicalization, as it does in lexicalized A′-dependencies. The case in point is represented by sluicing, more precisely by sluiced indirect wh-questions. The premise on which we built our research is Merchant's (2001 et seq.) structural approach to ellipsis. Accordingly, sluicing is the ellipsis phenomenon that allows the sentential portion of a question CP to be silenced at PF but still interpreted, leaving only a wh-phrase remnant (2) (Ross 1969; Merchant 2001).

(2) John ate something, but I don't know what <John ate _>

Under this approach, sluices involve a full-fledged indirect wh-question, structurally isomorphic to its antecedent, and deleted at PF. If fRM is a principle of locality operating in the syntax, similar acquisition trajectories are expected for lexical and sluiced indirect wh-questions, as they are syntactically similar to one another. Indeed, as it was found for lexical wh-questions, previous acquisition studies detected the subject > object asymmetry also in English and Spanish sluicing (Mateu & Hyams 2021; Mateu & Hyams 2025) and Mandarin sluice-like constructions (Liu et al. 2022). However, it is still unclear whether the reported asymmetry is due to fRM, since the authors of these studies did not manipulate fRM-relevant features and the subject advantage is amenable to different explanations (see Sections 3.1.4, 3.2.4, and 4.2). In turn, acquisition

data have not yet provided convincing evidence as to whether fRM regulates the acquisition of sluices.

To address this question, we designed three related experiments testing the comprehension of elliptical indirect wh-questions by Italian preschool children. The role of fRM in sluicing was verified by manipulating syntactically relevant features (1b) targeted in previous related studies, i.e. Lexical Restriction and Number, and comparing the different set-relations of inclusion, disjunction and intersection of the distinctness hierarchy (1c). The final answer we reach is that the acquisition of elliptical wh-questions is regulated by fRM according to the distinctness hierarchy. We conclude that fRM is independent of lexicalization.

The paper is structured as follows. Section 2 introduces the theoretical background and syntactic ingredients of Italian sluiced and lexical indirect wh-questions. Section 3 describes our study. Section 4 discusses the results, while Section 5 concludes the paper.

2 Italian sluicing: a brief overview

Building on Ross (1969), Merchant (2001) argues that in sluicing a full-fledged wh-question is syntactically projected and then deleted at PF under identity with its antecedent. Additionally, since the underlying wh-question is structurally isomorphic to its antecedent, as represented in angled brackets in (3a)[4], the sluiced sentence in (3a) is therefore syntactically equivalent to its lexically-realized counterpart (3b).[5]

(3) a. Gianni incontra qualcuno, ma non so chi <Gianni incontra>
John meet.3SG someone but not know.1SG who John meet.3SG
'John meets someone, but I don't know who <John meets>'

b. Gianni incontra qualcuno, ma non so chi Gianni incontra
John meet.3SG someone but not know.1SG who John meet.3SG
'John meets someone, but I don't know who John meets'

Adopting a cartographic approach to the left periphery, the wh-phrase *chi* ('who') moves from its vP-internal position to the specifier of a dedicated projection located in the CP field between FocusP and FinP, namely QembP, which serves as the structural position for wh-elements in embedded interrogative clauses (Rizzi & Bocci 2017). As no residual V2-requirement applies in embedded questions, differently from main questions, the finite predicate remains in the TP field. Importantly for the design choices in our experiments, the subject can target different positions:

[4] It should be noticed that non-isomorphic sources have also been claimed to constitute underlying structures of sluices. We will return to this point in Section 4.

[5] We abstract away from syntactic and pragmatic differences reported in the literature between the elliptical constituent and its lexical version (e.g., Cinque 2012).

a) Spec,TP as in (3b), b) Spec,TopicP, when dislocated as in (4a), or c) Spec,vP, when postverbal (Rizzi 1996).[6]

(4) a. Non so, Gianni, chi ha/abbia incontrato
not know.1SG John who have.3SG/have.3SG.SBJV met
'I don't know who John has met'

b. Non so chi ha/abbia incontrato Gianni
not know.1SG who have.3SG/have.3SG.SBJV met.3SG John
'I don't know who John has met'

Since Italian is a pro-drop language allowing for post-verbal subjects in wh-questions, (4b) is ambiguous: the wh-phrase *chi* ('who') can either be interpreted as a preverbal subject or, assuming *Gianni* to be a post-verbal subject, as a wh-interrogated object. Conversely, in (3b), where the subject is in preverbal position, no such ambiguity arises and the wh-phrase is interpreted as the object.

While the landing site of the wh-phrase in both sluiced and lexical indirect wh-questions is Spec,QembP[7], an additional operation applies in sluiced sentences at PF, as the complement of Qemb, i.e. FinP, undergoes deletion (Baltin 2010).

(5) [ForceP … [TopicP … [FocusP … [QembP *chi* ~~[FinP [TP … [vP]]]~~]]]]

With these assumptions, we expect fRM, the syntactic principle of locality, to apply to both lexical and sluiced wh-indirect questions, as they involve syntactically equivalent derivations.

3 Our experiments

To investigate how Italian-speaking children comprehend sluices, and whether fRM and its related distinctness hierarchy constrain their acquisition, we conducted three experimental studies. Experiment 1 compares lexical and sluiced subject- and object-extracted indirect wh-questions, assessing the effect of ellipsis in children's comprehension. Building on the results from Experiment 1, the other experiments focus only on sluiced sentences. Experiment 2 tests the disjunction set-relation by manipulating the lexical restriction feature, asking whether a lexical mismatch in object sluices improves children's comprehension. Experiment 3 tests the intersection set-relation by manipulating the Number feature, asking whether children's performance ameliorates with object sluices involving an intersection configuration.

Before detailing each experiment, we first outline the commonalities across the three studies. (i) All three experiments involved the same yes/no-question task, adapted from Mateu & Hyams

[6] We use Spec,vP as a cover label which includes the refined architecture of its left periphery proposed in Belletti (2004).

[7] This holds for all wh-phrases, except for the item *why* (Rizzi & Bocci 2017).

(2021) to Italian, with different stimuli for each experiment depending on the manipulated variables. Children were tested individually in a quiet room at their kindergarten. After being introduced to the task, children were shown an image on a screen, while a computer-simulated puppet asked whether they could see a particular character, and participants had to respond either yes or no. Each picture paired with a test sentence contained three characters in an A-B-C setting, performing the same action on one another. As in Mateu & Hyams (2021), children were instructed to respond by pointing to the target character only after the puppet had finished asking its question. If a child responded before the puppet had finished uttering its question, the trial was repeated once.

(ii) All the children included in our studies were Italian-speaking preschoolers and were reported to have normal hearing, vision, and language development according to the parental reports provided in the consent forms collected prior to the test session. Children were recruited from five different kindergartens in the Veneto region (north-east of Italy). Importantly, each child participated in only one experiment. We tested all children whose parents consented, but only those who correctly answered at least 8/12 control trials (binomial test, $p = .02$; three possible choices: A, B, or C) were included in the final analyses.

(iii) To build our stimuli, we employed only unambiguously representable lexemes (nouns and transitive predicates), ensuring they were part of children's vocabulary according to the Primo Vocabolario del Bambino (PVB), 'First Vocabulary of the Child', provided by the National Research Council (CNR).[8] All pictures were manually drawn using an iPad Pro with the graphic environment Procreate. Each trial was pre-recorded with a puppet-like voice, and the experiments were administered via a PowerPoint presentation.

3.1 Experiment 1

Experiment 1 investigated the acquisition of Italian indirect wh-questions, with the aim to (a) compare elliptical sentences and their lexicalized counterparts and (b) verify whether a subject > object asymmetry could be detected in both structures. Consequently, two research questions were formulated:

(Q1.1) Are sluiced sentences more difficult to comprehend than their lexicalized counterparts for Italian preschool children?

(Q1.2) Are object-extracted stimuli more difficult to comprehend than subject-extracted stimuli?

Regarding (Q1.1), if sluices are underlyingly indirect wh-questions (Merchant 2001), they are expected to be more challenging than their lexicalized counterparts for children, as their comprehension requires (i) identifying the antecedent clause, (ii) positing an identical structure

[8] The PVB can be consulted here. As the youngest children tested were aged 3;00, we ensured that all the lexical items used were ones acquired by the age of 30 months (i.e., 6 months prior to the age of the youngest children tested).

and meaning for the ellipsis site, based on the antecedent, and (iii) computing the A′-dependency within the ellipsis site. Lexicalized counterparts, by contrast, require only (iii). The combined demands of (i)–(iii) may exceed young children's working memory or processing capacities, thus making sluices more difficult to interpret.[9]

Regarding (Q1.2), if fRM constrains the acquisition of embedded wh-questions —whether sluiced or lexicalized— object-extracted sentences are predicted to be more difficult than subject-extracted ones, owing to the wh-object crossing the subject and thereby creating an intervention configuration disfavored in child grammar. By contrast, the wh-subject does not cross the direct object, thus preventing the emergence of intervention effects.

3.1.1 Participants

89 Italian-speaking children aged 3;00 to 5;11 participated in the experiment, but 14 were excluded because they did not pass the controls. Children were gathered into three age-groups: 3-, 4-, 5-year-olds in a cross-sectional design. 24 Italian-speaking adults, recruited from the same area where children's testing took place, were also tested as a control group. The breakdown of the participants by age is given in **Table 2**.

	Age 3	**Age 4**	**Age 5**	**Adults**
Participants	24 (14 females)	26 (11 females)	25 (14 females)	24 (16 females)
Age range	3;00–3;11	4;00–4;10	5;00–5;11	19;09–30;05
Mean	3;07	4;04	5;06	24;09
SD (months)	2.7	3.3	3.9	33.8

Table 2: Overview of participants' information.

3.1.2 Procedure and materials

Adopting a $2 \times 2 \times 2$ design, we manipulated three independent variables in the stimuli: (i) the phonological REALIZATION of the wh-embedded interrogative (Sluiced *vs*. Lexicalized); (ii) the EXTRACTION SITE of the wh-element (Subject *vs*. Object); (iii) the SCENARIO (Yes-Scenario *vs*. No-Scenario). While REALIZATION and EXTRACTION were manipulated linguistically, SCENARIO

[9] An anonymous reviewer raises the question of whether the same reasoning would also extend to VP-ellipsis. As far as we know, the comparison between VP-ellipsis and its lexicalized counterparts has not been directly tested in the acquisition literature, and therefore no strong or specific conclusions can be drawn. Nevertheless, given that ellipsis involves at least one additional operation, it is reasonable to expect a delayed emergence for VP-ellipsis as well, relative to its lexicalized counterparts. Suggestive evidence in this direction can be found in previous acquisition studies on VP-ellipsis (see Matsuo & Duffield 2001; Santos 2009), whose comprehension stimuli and production data appear consistent with this expectation, while not allowing a direct comparison between VP-ellipsis and lexicalized VP structures.

was manipulated visually, following Mateu & Hyams (2021). In Yes-Scenarios, the child was expected to point to a fully visible target character; in No-Scenarios, to a partially hidden one. This last manipulation ensured more variability among target responses.

Notably, ambiguous wh-questions featuring a WH_{SG}-V_{SG}-DP_{SG} configuration, where, in the absence of Number mismatch, the wh-pronoun could be either the subject or the direct object (see Section 2), were considered subject-extracted stimuli, in line with the choice made in previous studies on the acquisition of Italian relative clauses (e.g., Belletti et al. 2012; see Pagliarini & Guasti 2017).

Examples of our experimental sentences are given in (6) and (7), paired with pictures (**Figures 1–4**) that were designed to elicit a positive or a negative response by pointing either to the visible or to the partially hidden character. For instance, if children were correctly comprehending the subject sluice in (6a), they had to point to the visible girl in **Figure 1**, whereas when they heard the object sluice in (6b), associated with **Figure 2**, they had to point to the partially hidden character to answer correctly. Each experimental sentence was paired with a single picture requiring a target response. Importantly, the target type (visible *vs*. partially hidden) was counterbalanced across the conditions.

All the experimental sentences were controlled for other factors: (i) no mismatch in the Lexical Restriction, as the wh-element was always the lexically specified form *quale* + *NP* ('which + NP'), and, similarly, the other DP was always lexically restricted; (ii) no mismatch in the Number specification, as both the subject and the object were singular; (iii) no mismatch in the Animacy feature, as all the arguments were [+human]; (iv) no mismatch in the Gender feature, as in half of the stimuli all the arguments were [+feminine], while in the other half they were all [+masculine].

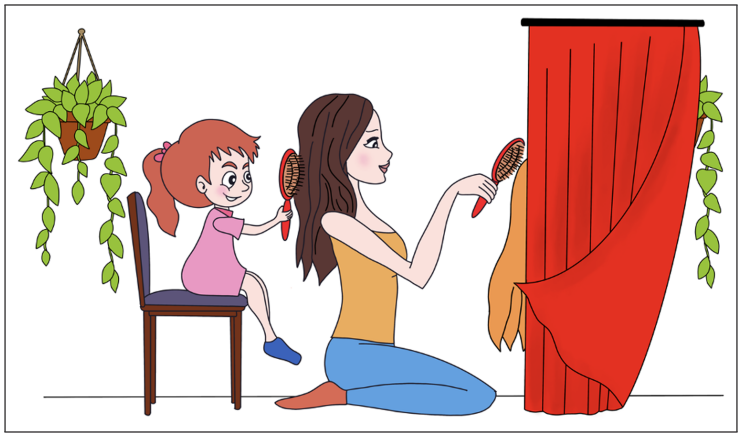


Figure 1: Yes-Scenario for (6a).

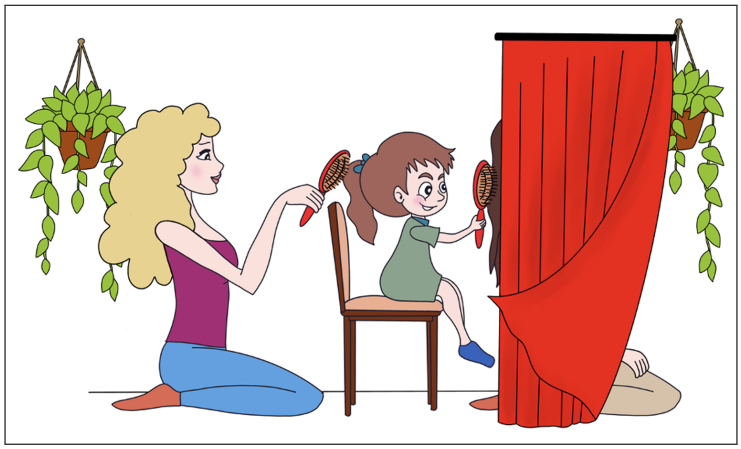


Figure 2: No-Scenario for (6b).

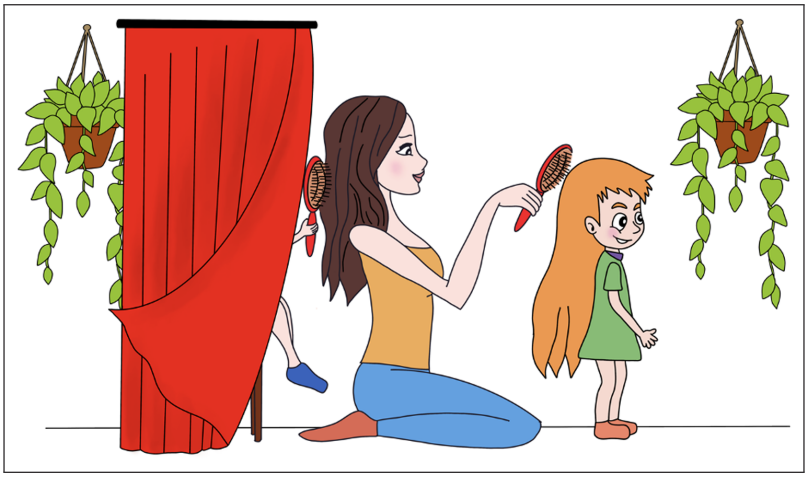


Figure 3: No-Scenario for (7a).

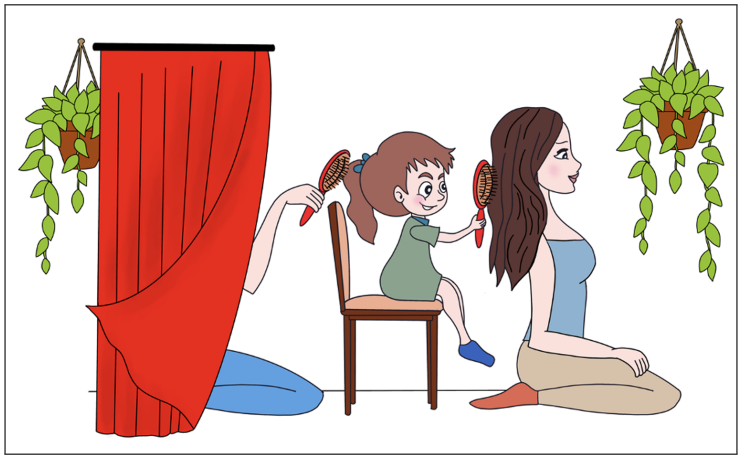


Figure 4: Yes-Scenario for (7b).

(6) SLUICED SENTENCES

SUBJECT SLUICE: NO INTERVENTION

a. Posso vedere che un-a bambin-a pettina l-a signor-a, puoi
can.1SG see that a-F.SG child-F.SG comb.3SG the-F.SG lady-F.SG can.2SG
vedere **qual-e** **bambin-a$_X$** <__$_Y$ pettina l-a signor-a >?
see which-SG child-F.SG comb.3SG the-F.SG lady-F.SG
'I can see that a girl is combing the lady, can you see which girl <__ is combing the lady>?'

OBJECT SLUICE: INTERVENTION

b. Posso vedere che l-a bambin-a pettina un-a signor-a, puoi
can.1SG see that the-F.SG child-F.SG comb.3SG a-F.SG lady-F.SG can.2SG
vedere **qual-e** **signor-a$_X$** <**la** **bambin-a$_Z$** pettina __$_Y$ >?
see which-SG lady-F.SG the-F.SG child-F.SG comb.3SG
'I can see that the girl is combing a lady, can you see which lady <the girl is combing __>?'

(7) LEXICALIZED SENTENCES

SUBJECT INDIRECT WH-QUESTION: NO INTERVENTION

a. Posso vedere che un-a bambin-a pettina l-a signor-a, puoi
can.1SG see that a-F.SG child-F.SG comb.3SG the-F.SG lady-F.SG can.2SG
vedere **qual-e** **bambin-a$_X$** __$_Y$ pettina l-a signor-a ?
see which-SG child-F.SG comb.3SG the-F.SG lady-F.SG
'I can see that a girl is combing the lady, can you see which girl __ is combing the lady?'

OBJECT INDIRECT WH-QUESTION: INTERVENTION

b. Posso vedere che l-a bambin-a pettina un-a signor-a, puoi
can.1SG see that the-F.SG child-F.SG comb.3SG a-F.SG lady-F.SG can.2SG
vedere **qual-e** **signor-a$_X$** **la** **bambin-a$_Z$** pettina __$_Y$?
see which-SG lady-F.SG the-F.SG child-F.SG comb.3SG
'I can see that the girl is combing a lady, can you see which lady the girl is combing __?'

The experiment comprised a total of 40 trials, divided between 24 test sentences, 12 controls, and 4 warm-up items. The 4 warm-up items were placed at the beginning of the experiment, with the aim of familiarizing the child with the task. The first two training items were subject sluiced sentences requiring a positive and a negative response, respectively. They were paired with pictures involving two characters, one visible and the other partially hidden, wherein the target character was performing an intransitive action. The other two training items were

yes/no-questions requiring a positive and a negative response, respectively. They were associated with pictures involving a transitive action in an A-B-C setting, which were carefully described by the puppet before uttering of the questions.

After the training phase, both test and control trials were administered in a pseudo-randomized order. Control trials were evenly divided between full subject and object embedded wh-questions featuring a reversal of the arguments from the preceding part of the sentence, making the subject of the first sentence become the object of the embedded question, and *vice versa* (8) (**Figures 5–6**). This ensured that children were paying attention to the question and not simply pointing to the referent of the indefinite in the first clause. Moreover, because subject questions in Italian are ambiguous between a subject and an object reading of the wh-element, the controls featured a mismatch in Number, with the interrogated argument always being singular and the other DP always being plural.[10]

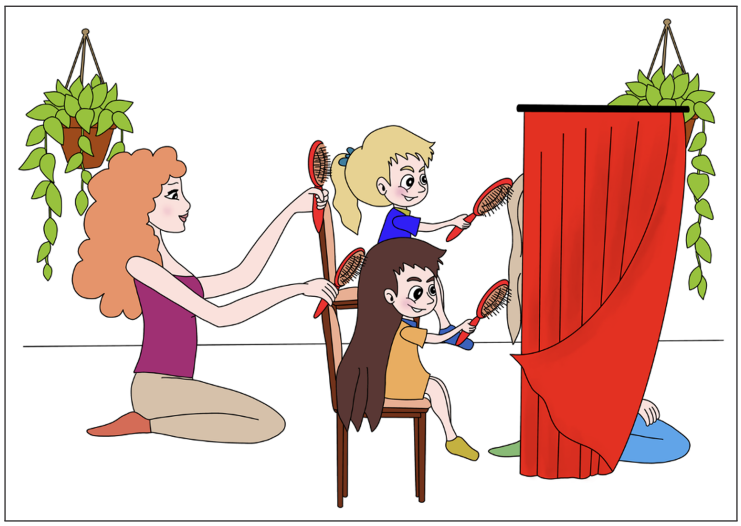


Figure 5: Yes-Scenario for (8a).

(8) a. Posso vedere che l-e bambin-e pettinano un-a signor-a, puoi
can.1SG see that the-F.PL child-F.PL comb.3PL a-F.SG lady-F.SG can.2SG
vedere qual-e signor-a pettina l-e bambin-e?
see which-SG lady-F.SG comb.3SG the-F.PL child-F.PL
'I can see that the girls are combing a lady, can you see which lady is combing the girls?'

[10] As Italian-speaking children acquire subject-verb agreement very early —according to Pizzuto & Caselli (1992), typically around 1;08–2;00— this mismatch in the control trials effectively disambiguates between the subject and the direct object, even for the youngest children tested.

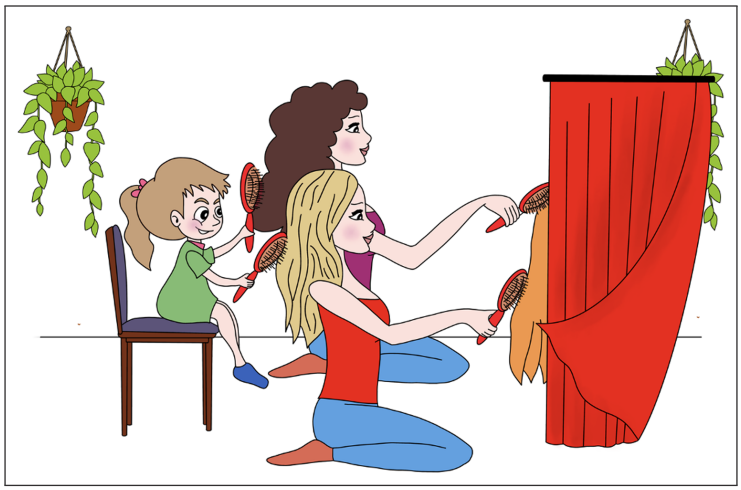


Figure 6: No-Scenario for (8b).

b. Posso vedere che un-a bambin-a pettina l-e signor-e, puoi
can.1SG see that a-F.SG child-F.SG comb.3SG the-F.PL lady-F.PL can.2SG
vedere qual-e bambin-a l-e signor-e pettinano?
see which-SG girl-F.SG the-F.PL lady-F.PL comb.3PL
'I can see that a girl is combing the ladies, can you see which girl the ladies are combing?'

3.1.3 Results

3.1.3.1 Statistical analyses

Figure 7 illustrates the rate of correct responses provided by children and adults in lexical and sluiced indirect wh-questions according to the Extraction Site of the wh-element. Overall, all participants performed above-chance, with accuracy increasing with age. Compared to their younger peers, older children pattern more closely to adults, who performed at ceiling in all conditions. Across all ages, children were more accurate in lexicalized than in sluiced indirect wh-questions. They were also consistently more accurate with subject- than object-extracted sentences, both in sluices (70.8% *vs.* 53.5% at age 3, 80.1% *vs.* 59% at age 4, 85.3% *vs.* 70.7% at age 5) and in lexicalized interrogatives (84.7% *vs.* 68.8% at age 3, 90.4% *vs.* 72.4% at age 4, 91.3% *vs.* 79.3% at age 5).

To statistically verify the results observed in **Figure 7**, participants' responses were fitted to linear mixed-effects logistic regression models (GLMMs) in R (R Core Team 2023). The analyses were conducted using the glmer function from the *lme4* package (Bates et al. 2015), with the specification of the logit link transformation, the binomial family and the bobyqa optimizer to enhance convergence stability during model fitting. Score was analyzed as a binary dependent

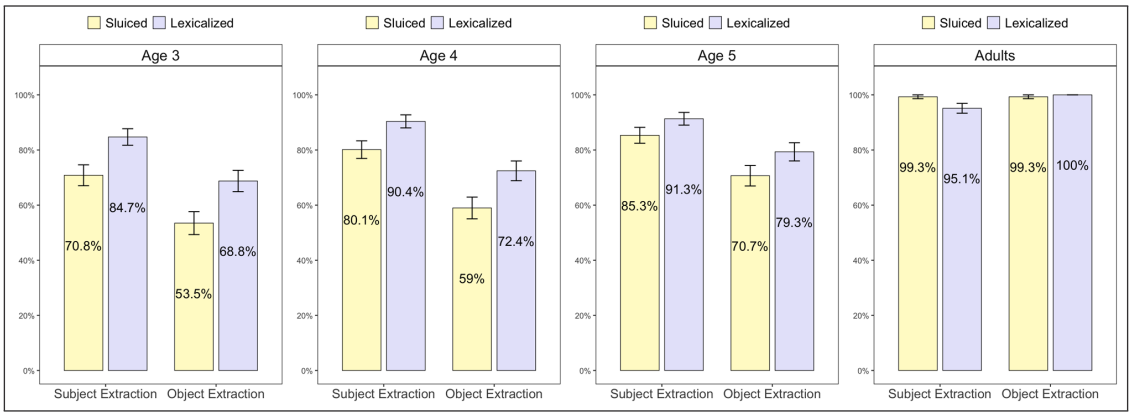


Figure 7: Response accuracy (%) by Extraction and Realization for each Age Group.

variable indicating response accuracy (correct, incorrect). As for predictors, we included Age (4 levels: Age 3, Age 4, Age 5, Adults), Realization (2 levels: Sluiced, Lexicalized), Extraction Site (2 levels: Subject, Object), Scenario (2 levels: Yes-Scenario, No-Scenario), also specifying their interactions. Factor levels were sum-contrast coded to aid interpretability. We also included random intercepts for Participants and Items to account for baseline variability in response accuracy across individuals and test items. Additional contrasts between factor levels were further checked using post-hoc pairwise comparisons with Tukey's correction. The estimates of the fixed effects of the model that best fitted our data are reported in **Table 3**.[11]

The model revealed a significant main effect of the predictor Age, as well as significant two-way interactions Extraction Site*Age and Realization*Age in the contrast Children *vs.* Adults.

As expected, the first Age contrast (Children *vs.* Adults) indicates that, overall, children did not perform in an adult-like fashion yet ($\beta = 3.64$, $SE = 0.59$, $z = 6.14$, $p < .001$). The other Age contrasts show that 3-year-olds significantly differ from 4-year-olds ($\beta = 0.74$, $SE = 0.24$, $z = 3.11$, $p = .002$), and 4-year-olds significantly differ from 5-year-olds ($\beta = 0.75$, $SE = 0.25$, $z = 3.01$, $p = .003$), suggesting that, altogether, children's performance gets progressively better with age.

The difference between children and adults clearly arises with respect to the lexicalization of the wh-embedded interrogative sentences, as indicated by the two-way interaction Realization*Age (Children *vs.* Adults) ($\beta = -1.98$, $SE = 0.82$, $z = -2.43$, $p = .015$): while children performed better with lexicalized than sluiced sentences, adults were at ceiling in both.

Turning to our second research question, namely the subject > object asymmetry, our model statistically confirms the descriptive overview reported in **Figure 7**. A significant Extraction

[11] Since we followed a model comparison approach to determine the best-fitting model for our data, given a fixed effect structure that included all our manipulated variables, the interaction between Extraction Site and Realization is not included in the output of the selected model, as it did not significantly improve the model fit.

	β	SE	z value	*p*
Intercept	2.215	0.166	13.374	<.001
Scenario	0.150	0.134	1.119	.263
Extraction Site	–0.227	0.288	–0.787	.431
Realization	0.179	0.230	0.780	.435
Age (Children *vs*. Adults)	3.638	0.593	6.139	<.001
Age (Children Age 3 *vs*. Age 4)	0.744	0.239	3.109	.002
Age (Children Age 4 *vs*. Age 5)	0.751	0.249	3.014	.003
Extraction Site * Age (Children *vs*. Adults)	3.142	1.066	2.946	.003
Extraction Site * Age (Children Age 3 *vs*. Age 4)	–0.279	0.330	–0.845	.398
Extraction Site * Age (Children Age 4 *vs*. Age 5)	0.064	0.358	0.178	.858
Realization * Age (Children *vs*. Adults)	–1.981	0.816	–2.429	.015
Realization * Age (Children Age 3 *vs*. Age 4)	–0.180	0.326	–0.552	.581
Realization * Age (Children Age 4 *vs*. Age 5)	–0.276	0.349	–0.791	.429

Table 3: Output of the selected mixed effect logistic regression model (Full Model Summary: AIC = 1961.6; BIC = 2048.2; LogLik = –965.8; Dev = 1931.6).

Site*Age (Children *vs*. Adults) interaction ($\beta = 3.14$, $SE = 1.07$, $z = 2.95$, $p = .003$), shows that adults performed at ceiling for both subject- and object-extracted stimuli, while children responded more accurately to the former than the latter.[12] Post-hoc comparisons showed that this asymmetry is consistent within each age group of children (age 3: $\beta = 0.87$, $SE = 0.21$, $z = 4.24$, $p < .001$; age 4: $\beta = 1.18$, $SE = 0.22$, $z = 5.46$, $p < .001$; age 5: $\beta = 0.98$, $SE = 0.24$, $z = 4.11$, $p < .001$).

Notably, model comparisons showed that the Extraction Site*Realization interaction did not significantly improve model fit ($\chi^2(1) = 0.215$, $p = .643$), as expected under our theoretical assumption. Indeed, since lexical and sluiced interrogative questions involve syntactically equivalent structures, the asymmetry was predicted to arise in both sentences.

3.1.3.2 Individual analyses

To verify the consistency of our statistical results within participants, we conducted two separate individual analyses. The first analysis investigated the Realization*Age interaction, aiming to determine whether the lexicalization of wh-embedded interrogative sentences constrains each child's acquisition path. For each participant, we counted the number of correct responses in the two Realization conditions (Sluiced, Lexicalized). A structure type was considered acquired if the participant provided at least 8/12 correct responses, as indicated by a binomial test. Response

[12] This was so despite the fact that subject wh-questions were ambiguous between subject and object wh-questions due to the option of having post-verbal subjects in Italian.

patterns could fall within one of the following four: (i) No acquisition of indirect wh-questions, comprising children who have not yet acquired either lexicalized or sluiced sentences (Pattern 1);[13] (ii) Acquisition of lexicalized interrogatives, encompassing children who have acquired lexicalized wh-questions but not their elliptical counterparts (Pattern 2), and (iii) Acquisition of both lexicalized and sluiced interrogatives, including children who handle both sentence types (Pattern 3); (iv) Acquisition of sluiced questions but not their lexicalized counterparts (Pattern 4).

	Pattern 1 **[–LEX,–SLU]**	**Pattern 2** **[+LEX,–SLU]**	**Pattern 3** **[+LEX,+SLU]**	**Pattern 4** **[–LEX,+SLU]** **(OUTLIERS)**
Age 3	4/24 (16.6%)	9/24 (37.5%)	10/24 (41.6%)	1/24 (4.1%)
Age 4	1/26 (3.8%)	9/26 (34.6%)	14/26 (53.8%)	2/26 (7.7%)
Age 5	0/25 (0.0%)	5/25 (20.0%)	20/25 (80.0%)	0/25 (0.0%)
Adults	0/24 (0.0%)	0/24 (0.0%)	24/24 (100.0%)	0/24 (0.0%)

Table 4: Number of participants (%) exhibiting each pattern across age groups.

As shown in **Table 4**, the distribution of these patterns across age groups is not random (Fisher's Exact Test with Monte Carlo method, $p = .049$)[14], suggesting an acquisition path roughly correlated with age. Numerically, Pattern 1 primarily comprises some residual younger children, and Pattern 2 is mostly found among 3- and 4-year-olds. Pattern 3 mainly encompasses 5-year-old children (FET-MC, $p = .037$, Bonferroni-corrected), along with all adult participants. Crucially, virtually no children showed a pattern consistent with understanding sluices but not lexicalized wh-questions (Pattern 4). This is consistent with theoretical expectations since sluices presuppose the structure of lexicalized wh-questions and require additional operations.[15]

[13] An anonymous reviewer asks why embedded wh-questions should pose particular difficulties. While grammatical knowledge of (subject) matrix wh-questions is in place from an early age (Seidl et al. 2003), embedded wh-questions take longer (e.g., de Villiers 1991), possibly because they require lexical knowledge of the types of verbs that subcategorize for the CP and, more importantly, because they involve greater structural complexity due to the presence of multiple clauses, which likely increases cognitive demands. Thus, difficulties with embedded questions in the examined age groups may stem from processing or working memory limitations rather than incomplete grammatical knowledge.

[14] Statistical analyses on the counts were performed using Fisher's Exact Test with Monte Carlo method (hereafter FET-MC), conducted on child participants only. Specifically, an overall FET-MC was first applied to the full set of child data to assess general associations. Subsequently, post-hoc pairwise comparisons between relevant age groups for each response pattern were carried out using FET-MC with Bonferroni correction to control for multiple comparisons. These procedures were applied consistently across all individual analyses presented in this paper. We report statistical results when significant.

[15] It is worth noting that only one 3-year-old and two 4-year-old children fall within Pattern 4. Two of these cases, i.e. the 3-year-old and one 4-year-old scoring 8/12 *vs*. 7/12 and 9/12 *vs*. 7/12, may be attributed to our arbitrary definition of

Hence, the comprehension of indirect wh-questions proceeds in a three-step fashion: (i) STAGE I, in which children do not comprehend indirect wh-questions, (ii) STAGE II, in which they comprehend lexicalized but not sluiced questions, (iii) STAGE III, in which they successfully comprehend both structures.

The second individual analysis examined our second statistical result, i.e. Extraction Site*Age, within participants. We counted the number of correct responses for subject- and object-extracted interrogatives, collapsing both sluiced and lexicalized interrogatives, thereby mirroring the interaction detected by the model. A threshold of 8/12 correct responses was maintained to define a structure type as acquired. Again, three response patterns emerged: (i) No acquisition of indirect wh-questions, comprising children who have not acquired either subject- or object-extracted sentences (Pattern 1), (ii) Acquisition of subject-extracted sentences, encompassing children who comprehended subject-extracted sentences but not object-extracted ones (Pattern 2), and (iii) Acquisition of both subject-extracted and object-extracted sentences, including children who have acquired both sentence types (Pattern 3). Crucially, in line with the predictions of fRM, no participant instantiated the reverse of Pattern 3, i.e. Pattern 4 —that is, having acquired object-extracted but not subject-extracted sentences.

	Pattern 1 [–SUBJ,–OBJ]	**Pattern 2** [+SUBJ,–OBJ]	**Pattern 3** [+SUBJ,+OBJ]	**Pattern 4** [–SUBJ,+OBJ] (OUTLIERS)
Age 3	3/24 (12.5%)	9/24 (37.5%)	12/24 (50.0%)	0/24 (0.0%)
Age 4	0/26 (0.0%)	13/26 (50.0%)	13/26 (50.0%)	0/26 (0.0%)
Age 5	0/25 (0.0%)	8/25 (32.0%)	17/25 (68.0%)	0/25 (0.0%)
Adults	0/24 (0.0%)	0/24 (0.0%)	24/24 (100.0%)	0/24 (0.0%)

Table 5: Number of participants (%) exhibiting each pattern across age groups.

As shown in **Table 5**, the distribution of patterns across age groups suggests a possible age-related acquisition trajectory. However, this variation did not reach statistical significance (FET-MC, $p = .12$), possibly because most children had already acquired subject-extracted sentences, and a finer-grained analysis of the acquisition of object dependencies may be required (see Experiments 2 and 3 in Sections 3.2 and 3.3). Descriptively, Pattern 1 occurs only among some 3-year-olds, whereas Pattern 2 is mostly instantiated by 3- and 4-year-olds. Pattern 3, besides including all adult participants, is primarily observed in 5-year-olds.

acquisition, while the other 4-year-old child (scoring 11/12 *vs*. 7/12) represents an outlier for the individual analysis, for whom we lack an explanation.

Thus, the comprehension of indirect wh-questions proceeds in a three-step fashion: (i) STAGE I, in which children do not comprehend indirect wh-questions; (ii) STAGE II, in which children comprehend subject but not object wh-questions, (iii) STAGE III, in which children comprehend both subject and object wh-questions.

3.1.4 Interim conclusion

In Experiment 1, we tested children's comprehension of indirect wh-questions, comparing lexical and elliptical structures. Overall, results show that children performed significantly better with fully lexicalized indirect wh-questions than with ellipsis, suggesting that ellipsis incurs a cost for children. This cost decreases with age: the performance gap between the two conditions narrows over time, disappearing among adults. The individual analysis further revealed that the comprehension of lexical wh-questions precedes the comprehension of sluiced questions.

In addition, the experiment confirmed the already well-established subject > object asymmetry in children's comprehension of both elliptical and non-elliptical indirect wh-questions in Italian, with better performance on subject-extracted than object-extracted stimuli. Moreover, individual data suggest a stepwise acquisition trajectory, with subject-extracted dependencies preceding object-extracted dependencies.

The subject > object asymmetry observed in the comprehension of sluiced sentences aligns with our structural assumption to sluicing and supports the grammar-based account of fRM (Rizzi 2004; 2018). However, alternative explanations cannot be excluded, including those arisen within input-frequency based approaches, which would predict better performance in questions that maintain the canonical SVO order of Italian, i.e. subject wh-questions (e.g., Diessel & Tomasello 2005), or other structure-based models in which the subject advantage is attributed to the shorter distance between the two dependents in terms of number of syntactic nodes (e.g., O' Grady 1997 et seq.) (see Section 4.1 for evaluation of domain-general processing-based accounts).

Hence, to verify whether the subject > object asymmetry we found in Italian sluices was determined by fRM specifically, we conducted a second experiment which targeted the distinctness hierarchy at the basis of fRM, comparing the disjunction and inclusion set-relations.

3.2 Experiment 2

Experiment 2 manipulated the lexical specification of the interrogative constituent in sluiced sentences, using either the bare wh-pronoun *chi* ('who'), i.e. [+Q], or the lexically restricted wh-element *quale + NP* ('which + NP'), i.e. [+Q, +NP]. We thus created mismatch (i.e. disjunction) and match (i.e. inclusion) configurations between the wh-element and the other DP argument

involved in the stimuli, which was always lexically restricted, i.e. [+NP]. The aim was to verify whether children's difficulties with object sluices can be reduced in the presence of a disjunction configuration, as would be expected under fRM. Two research questions were formulated:

(Q2.1) Are subject sluices easier to comprehend than object sluices?

(Q2.2) Does a lexical mismatch improve children's performance on object sluices?

Regarding (Q2.1), based on previous findings from Experiment 1 and in line with fRM, subject sluices are predicted to be easier to comprehend than object sluices, as only the former involve no intervention (**Table 1**).

As for (Q2.2), when an intervention configuration arises —i.e. in object sluices— children's performance is expected to improve in lexical mismatch configurations (i.e., disjunction: [+Q] *vs.* [+NP]) relative to lexical match configurations (i.e., inclusion: [+Q,+NP] *vs.* [+NP]). Put differently, a mismatch in lexical restriction is expected to weaken intervention effects by increasing the featural distinctness between the wh-object and the intervening subject, thereby enhancing children's comprehension.

3.2.1 Participants

89 Italian-speaking children aged 3;00 to 5;11 participated in the experiment, none of whom had taken part in the previous one. However, the final dataset comprised 83 Italian-speaking children, as six of the children tested did not pass the controls. Children were grouped into three age categories: 3-, 4-, and 5-year-olds in a cross-sectional design. 26 Italian-speaking adults, recruited from the same area where children's testing took place, were also tested as a control group. The breakdown of the participants by age is given in **Table 6**.

	Age 3	**Age 4**	**Age 5**	**Adults**
Participants	24 (13 females)	27 (9 females)	32 (16 females)	26 (16 females)
Age range	3;00–3;11	4;00–4;11	5;00–5;11	18;09–26;01
Mean	3;07	4;05	5;06	23;08
SD (months)	2.7	2.9	4.0	22.5

Table 6: Overview of participants' information.

3.2.2 Procedure and materials

We adopted the same materials and procedure as in Experiment 1, but participants were tested only on sluiced sentences.

Within a $2 \times 2 \times 2$ design, we manipulated three independent variables in the stimuli: (i) the EXTRACTION SITE of the wh-element (Subject *vs.* Object); (ii) the LEXICAL RESTRICTION of the wh-element (lexically restricted *vs.* bare), using either *quale* + *NP* ('which + NP') or *chi* ('who'), thereby creating match and mismatch configurations between the remnant and the other lexically specified DP involved in the stimuli (Match, Mismatch); (iii) the SCENARIO (Yes-Scenario *vs.* No-Scenario). None of the stimuli presented other featural mismatches and all were built using the same lexemes adopted in Experiment 1.

Examples of our experimental sentences are given in (9) and (10), with the paired pictures shown in **Figures 8–11**.

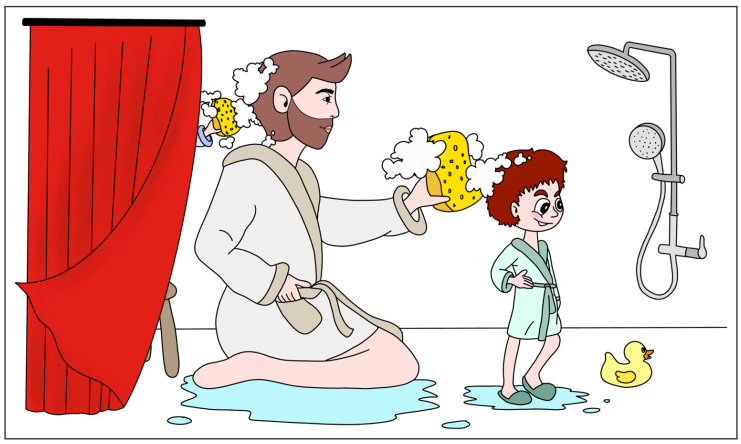


Figure 8: No-Scenario for (9a).

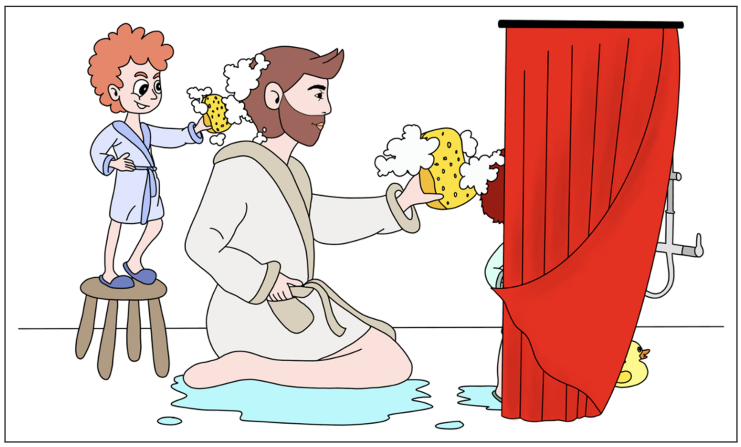


Figure 9: Yes-Scenario for (9b).

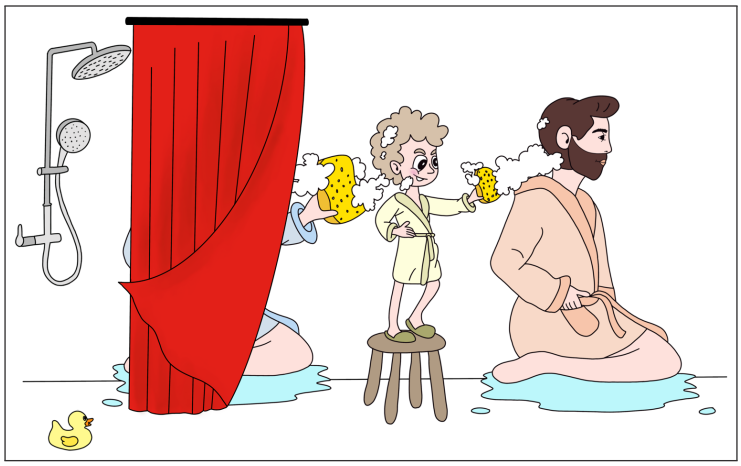


Figure 10: Yes-Scenario for (10a).

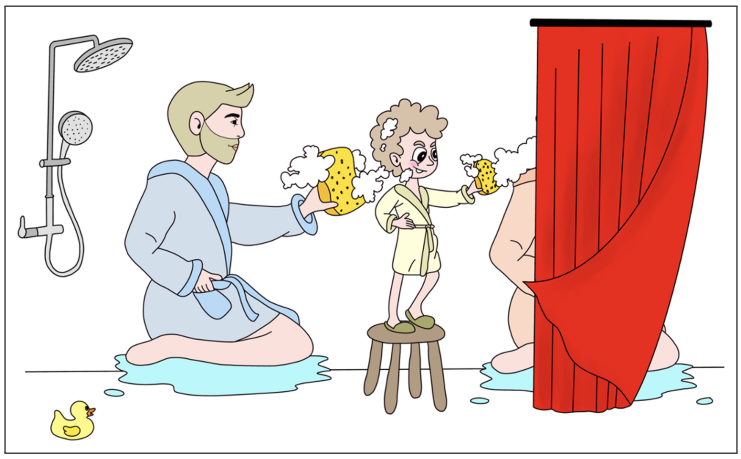


Figure 11: No-Scenario for (10b).

(9) SUBJECT SLUICES: NO INTERVENTION

LEXICAL MATCH

a. Posso vedere che un bambin-o lava il signor-e, puoi
can.1SG see that a-M.SG child-M.SG wash.3SG the-M.SG sir-M.SG can.2SG
vedere **qual-e** **bambin-o$_X$** <__$_Y$ lava il signor-e>?
see which-SG child-M.SG wash.3SG the-M.SG sir-M.SG
'I can see that a boy is washing the sir, can you see which child <__ is washing the sir>?'

LEXICAL MISMATCH

b. Posso vedere che qualcuno lava il signor-e, puoi vedere **chi$_X$**
can.1SG see that someone wash.3SG the-M.SG sir-M.SG can.2SG see who
< __$_Y$ lava il signor-e >?
wash.3SG the-M.SG sir-M.SG
'I can see that someone is washing the sir, can you see who < __ is washing the sir >?'

(10) OBJECT SLUICES: INTERVENTION

LEXICAL MATCH: INCLUSION CONFIGURATION

a. Posso vedere che il bambin-o lava un signor-e
can.1SG see that the-M.SG child-M.SG wash.3SG a-M.SG sir-M.SG
puoi vedere **qual-e signor-e$_{X\,[+Q,+NP]}$** < **il** **bambin-o$_{Z\,[+NP]}$**
can.2SG see which-SG sir-M.SG the-M.SG child-M.SG
lava __$_{Y\,[+Q,+NP]}$ >?
wash.3SG
'I can see that the boy is washing a sir, can you see which sir < the boy is washing __ >?'

LEXICAL MISMATCH: DISJUNCTION CONFIGURATION

b. Posso vedere che il bambin-o lava qualcuno, puoi
can.1SG see that the-M.SG child-M.SG wash.3SG someone can.2SG
vedere **chi$_{X\,[+Q]}$** < **il** **bambin-o$_{Z\,[+NP]}$** lava __$_{Y\,[+Q]}$ >?
see who the-M.SG child-M.SG wash.3SG
'I can see that the boy is washing someone, can you see who < the boy is washing __ >?'

The task comprised 40 trials, starting with the same 4 warm-ups as in Experiment 1. Again, 12 full subject and object embedded wh-questions with argument reversal were used as controls, equally divided for the type of the wh-element involved (e.g., for the 6 subject controls, 3 were with the bare wh-element *chi* and 3 with the lexically restricted wh-element *quale + NP*) and balanced for Scenario. All the controls featured a mismatch in Number, with the interrogated argument always being singular and the other DP always being plural.

3.2.3 Results

3.2.3.1 Statistical analyses

Figure 12 illustrates our results. As in Experiment 1, participants performed above chance overall, with accuracy increasing progressively with age: older children provided more target-like responses and patterned more closely with adults. Consistent with the previous experiment,

subject sluices were well comprehended at all ages, whereas object sluices remained challenging, even for older children.

However, **Figure 12** also shows that object sluices are better comprehended when involving the bare wh-element *chi* (i.e., mismatch conditions) than the lexically restricted *quale* + *NP* (i.e., match conditions) (69.4% *vs*. 56.9% at age 3, 80.2% *vs*. 61.7% at age 4, 85.9% *vs*. 71.4% at age 5), while no such difference appeared in subject sluices (73.6% *vs*. 78.5% at age 3, 87.7% *vs*. 87% at age 4, 94.3% *vs*. 92.7% at age 5).

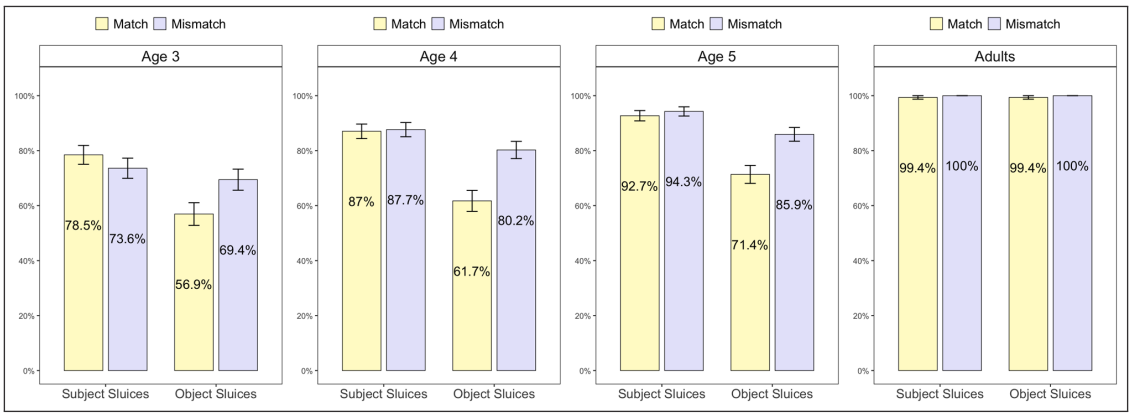


Figure 12: Response accuracy (%) by Extraction and Lexical Restriction for each Age Group.

To statistically verify the results observed in **Figure 12**, participants' responses were analyzed using linear mixed-effects logistic regression models (GLMMs) in R (R Core Team 2023). The analyses were conducted using the same statistical tools outlined for Experiment 1. As for predictors, we included Age (4 levels: Age 3, Age 4, Age 5, Adults), Extraction Site (2 levels: Subject, Object), Lexical Restriction (2 levels: Match, Mismatch), Scenario (2 levels: Yes-Scenario, No-Scenario), also specifying their interactions. Random intercepts were also specified for Participants and Items, to model baseline differences in accuracy of responses. The estimates of the fixed effects of the model that best fitted our data are reported in **Table 7**.

The model revealed main significant effects of the three predictors Age, Extraction Site and Lexical Restriction, as well as the two-way interaction Extraction Site*Lexical Restriction.

As in Experiment 1, the first Age contrast (Children *vs*. Adults) indicates that, overall, children gave significantly fewer correct responses than adults, who performed at ceiling in all conditions ($\beta = 4.59$, $SE = 0.72$, $z = 6.41$, $p < .001$). The progressively increasing accuracy across age groups shown in **Figure 12** is further confirmed by the remaining Age contrasts: 3-year-olds differed from 4-year-olds ($\beta = 1.14$, $SE = 0.23$, $z = 4.88$, $p < .001$), and 4-year-olds differed from 5-year-olds ($\beta = 1.14$, $SE = 0.23$, $z = 4.84$, $p < .001$).

	β	SE	z value	*p*
Intercept	2.666	0.205	13.002	<.001
Age (Children *vs.* Adults)	4.586	0.716	6.406	<.001
Age (Children Age 3 *vs.* Age 4)	1.139	0.234	4.876	<.001
Age (Children Age 4 *vs.* Age 5)	1.135	0.234	4.842	<.001
Scenario	0.265	0.188	1.410	.159
Extraction Site	–0.956	0.189	–5.051	<.001
Lexical Restriction	0.426	0.189	2.254	.024
Extraction Site * Lexical Restriction	0.912	0.378	2.412	.016

Table 7: Output of the selected mixed effect logistic regression model (Full Model Summary: AIC = 1904.6; BIC = 1963.3; LogLik = –942.3; Dev = 1884.6).

The significant effect of Extraction Site indicates higher accuracy in subject than in object sluices ($\beta = -0.96$, $SE = 0.19$, $z = -5.05$, $p < .001$), thus replicating the asymmetry observed previously.

Notably, the model also detected a significant main effect of Lexical Restriction ($\beta = 0.43$, $SE = 0.19, z = 2.25, p = .024$), indicating that preschoolers performed better on sluices involving *chi* (i.e., mismatch condition) than on those with *quale*+*NP* (i.e., match condition). Moreover, the significant interaction between Extraction Site and Lexical Restriction shows that accuracy was higher in object sluices with bare wh-elements than in those with lexically restricted ones ($\beta = 0.91$, $SE = 0.38$, $z = 2.41$, $p = .016$). Importantly, no such difference emerged for subject sluices, as further checked by post-hoc Tukey's tests ($\beta = 0.03$, $SE = 0.28$, $z = 0.11$, $p = 1.0$).

3.2.3.2 Individual analyses

To verify the consistency of our results within participants, we conducted an individual analysis consisting of two subparts.

First, as we did for Experiment 1, we examined the subject > object asymmetry detected by the statistical model within each individual's acquisition path. Specifically, we counted the number of correct responses across the two conditions related to the variable Extraction Site (Subject, Object). To define a structure type as acquired, we fixed a criterion of 8/12 correct responses for the given structure, as indicated by a binomial test. We identified three different response patterns: (i) No acquisition of sluicing, comprising children who have not yet acquired either subject or object sluices (Pattern 1); (ii) Acquisition of subject sluices, including children who correctly comprehended subject sluices but still struggled with object sluices (Pattern 2); (iii) Acquisition of both subject and object sluices, including children who comprehended both sentence types (Pattern 3). Notably, the fourth logical possibility, i.e. having acquired object sluices but not subject sluices (Pattern 4), was not instantiated in our dataset.

Since lexical mismatch improved children's comprehension of object sluices (see Section 3.2.3.1), we further included this variable in Pattern 3 (the only one in which object sluices were acquired). In this sub-part of the individual analysis, with 6 stimuli for each condition, acquisition was defined as at least 5/6 correct responses, as indicated by a binomial test. Accordingly, Pattern 3 was split into two sub-groups: (i) Acquisition of object sluices involving a lexical mismatch configuration, comprising children who correctly comprehended object sluices involving the bare wh-element *chi*, but not those involving the lexically restricted wh-element *quale* + *NP* (Pattern 3A); (ii) Acquisition of both object sluices involving a mismatch configuration and those involving a match configuration, encompassing children who performed above-chance in both object sluices with *chi* and those with *quale* + *NP*.

In addition to Patterns 3A and 3B, two other possibilities arise: (i) the reverse of Pattern 3A, i.e., having acquired object sluices with a match configuration but not those with a mismatch configuration (henceforth, Pattern 3C); and (ii) the NAC (Nearly-Above Chance) Pattern, i.e. scoring exactly 4/6 on both object sluices with lexical match and those with lexical mismatch, yielding a total of 8/12 correct responses in object sluices overall. While no participant displayed Pattern 3C, as predicted by fRM, four 3-year-olds and two 4-year-olds exhibited the NAC Pattern.

Leaving the NAC Pattern aside, as being rather uninformative, and comparing the other patterns, we can trace an acquisition path. **Table 8** reports participants' distribution across patterns, suggesting a four-stage acquisition path correlated with age (Fisher's Exact Test with Monte Carlo method, $p < .001$).[16]

	Pattern 1 [-SUBJ,-OBJ]	**Pattern 2** [+SUBJ,–OBJ]	**Pattern 3** [+SUBJ, +OBJ]			**Pattern 4** [–SUBJ, +OBJ] (OUTLIERS)
			Pattern 3A [+MM_{OBJ},–M_{OBJ}]	**Pattern 3B** [+MM_{OBJ}, +M_{OBJ}]	**Pattern 3C** [–MM_{OBJ}, +M_{OBJ}] (OUTLIERS)	
Age 3	4/24 (12.5%)	8/24 (33.3%)	7/24 (29.2%)	1/24 (4.2%)	0/24 (0.0%)	0/24 (0.0%)
Age 4	0/27 (0.0%)	8/26 (29.6%)	12/27 (44.4%)	5/27 (29.2%)	0/27 (0.0%)	0/27 (0.0%)
Age 5	0/32 (0.0%)	6/32 (18.8%)	9/32 (28.1%)	17/32 (53.1%)	0/32 (0.0%)	0/32 (0.0%)
Adults	0/26 (0.0%)	0/26 (0.0%)	0/26 (0.0%)	26/26 (100.0%)	0/26 (0.0%)	0/26 (0.0%)

Table 8: Acquisition path: frequency and percentages for each pattern by Age.

Specifically, only a few 3-year-olds exhibit Pattern 1 (FET-MC, $p = .014$, Bonferroni-corrected), whereas Pattern 3B, at the opposite pole of the acquisition path, primarily appears among 5-year-olds (FET-MC, $p = .001$, Bonferroni-corrected) alongside all the adults. Intermediate Patterns, i.e. Pattern 2 and Pattern 3A, are instantiated by children of all age

[16] Statistical analyses on the counts were performed as detailed in footnote 14, using Fisher's Exact Test with Monte Carlo method (hereafter FET-MC).

groups, though the former is mostly numerically represented by those aged 3 and 4, and the latter by those aged 4 and 5. Thus, the comprehension of sluicing proceeds in a four-step fashion: (i) STAGE I, where children fail to comprehend both subject and object sluices; (ii) STAGE II, where children comprehend subject sluices but not object sluices; (iii) STAGE III, where children comprehend subject sluices and object sluices involving a lexical mismatch; (iv) STAGE IV, in which children comprehend subject sluices as well as object sluices, both with and without a lexical mismatch.

3.2.4 Interim conclusion

Experiment 2 tested the comprehension of subject and object sluices featuring either the lexically restricted wh-remnant *quale + NP* ('which + NP') or the bare *chi* ('who'). Results confirm the asymmetry found in the previous experiment, as Italian preschoolers exhibited a significant subject advantage in the sluices. Furthermore, Italian children performed better in object sluices with *chi* (i.e., mismatch condition) than in those with *quale + NP* (i.e., match condition), whereas no such amelioration effect arose in subject sluices. Notably, object sluices with a mismatch in the lexical restriction between the wh-phrase and the subject DP involve a disjunction configuration, while those with both lexically restricted involve an inclusion configuration. As expected under a fRM approach, the former were better comprehended than the latter. Indeed, according to the distinctness hierarchy, the inclusion relation, but not disjunction, is penalized.

Nevertheless, the results in object sluices are compatible with other explanations as well. The performance gap may be indeed related to the different properties featured by the two wh-remnants. Specifically, *quale + NP* differs from *chi* with respect to agreement: whereas *quale* checks and values its Number feature in the Agree relation with the NP, *chi* is underspecified for person and number, thus requiring only the default agreement for the third person singular. Moreover, although both wh-remnants are contextually D-linked in the presence of pictures (Friedmann et al. 2009), *quale + NP* is inherently D-linked, thus targeting a distinct position in the left periphery compared to *chi* (Rizzi 2018). Additionally, the use of *quale + NP* may involve additional pragmatic import, as it triggers a presupposition of existence (Szabolcsi & Zwarts 1993). As a matter of fact, lexically restricted wh-elements are reported to be acquired later than bare wh-pronouns (Bloom et al. 1982). However, if children's performance gap were due to the different properties of the two remnants, a similar amelioration should have appeared in subject sluices, contrary to fact. Therefore, alternatively to a fRM explanation, a combined complexity effect might be advanced, assuming that the difficulties due to the lexically specified wh-remnant only arise in object sluices, as they are independently more problematic than subject sluices. Conversely, the effect of the lexical restriction is masked in subject sluices, which are easier for children. Put differently, only the combination of the two independently motivated effects may exceed children's computational resources, thus accounting for our results.

To further verify the role of fRM and its distinctness hierarchy, we conducted a third experiment testing the intersection set-relation in comparison to the inclusion relation.

3.3 Experiment 3

Experiment 3 targeted the intersection set-relation created by manipulating the Number feature. While the wh-elements remained identical across all conditions —the singular lexically restricted wh-element *quale* + *NP* ('which + NP') [+ Q, + NP, + SG]— the other DPs involved in the stimuli were always lexically restricted as well, but either matched, i.e. [+ NP, + SG], or mismatched, i.e. [+ NP, + PL], the Number feature of the wh-phrase, thereby creating inclusion and intersection configurations, respectively. Therefore, two research questions were formulated:

(Q3.1) Are subject sluices easier to comprehend than object sluices?

(Q3.2) Does a Number mismatch improve children's performance on object sluices?

Regarding (Q3.1), consistent with prior findings and the predictions for Experiment 2, subject sluices are expected to be easier to comprehend than object sluices.

Regarding (Q3.2), children's performance is expected to improve in object sluices involving Number mismatch configurations (i.e., intersection: [+ Q, + NP, + SG] *vs.* [+ NP, + PL]) compared to Number match configurations (i.e., inclusion: [+ Q, + NP, + SG] *vs.* [+ NP, + SG]), on the grounds that greater featural distinctness between the wh-element (X) and the intervener (Z) reduces intervention effects and, in turn, facilitates children's comprehension, as predicted by Rizzi's (2018) distinctness hierarchy (**Table 1**).

3.3.1 Participants

90 Italian-speaking children aged 3;00 to 5;11 participated in the experiment, none of whom had taken part in the previous ones. However, the final dataset comprised 80 Italian-speaking children, as ten of the children tested did not pass the controls. 24 Italian-speaking adults, recruited from the same area where children's testing took place, were also tested as a control group. The breakdown of the participants by age is given in **Table 9**.

	Age 3	**Age 4**	**Age 5**	**Adults**
Participants	25 (12 females)	26 (15 females)	29 (20 females)	24 (13 females)
Age range	3;00–3;11	4;00–4;10	5;00–5;11	18;03–29;01
Mean	3;07	4;05	5;06	23;10
SD (months)	2.8	3.3	3.9	34.3

Table 9: Overview of participants' information.

3.3.2 Procedure and materials

Using the same procedure and materials as in Experiments 1 and 2, participants were tested only on sluiced sentences.

Adopting a $2 \times 2 \times 2$ design, we manipulated three independent variables in the stimuli: (i) the EXTRACTION SITE of the wh-element (Subject *vs*. Object); (ii) the NUMBER feature of the DP arguments, thereby creating match and mismatch configurations between the wh-remnant, which was always maintained as the singular lexically specified wh-element *quale* + *NP* ('which + NP'), and the other DP involved in the stimuli, which was either singular or plural (Match, Mismatch); (iii) the SCENARIO (Yes-Scenario *vs*. No-Scenario). None of the stimuli presented other featural mismatches and all were built using the same lexemes adopted in the previous experiments. The pictures adopted were the same used in Experiments 1 and 2, with the exception of those paired with the stimuli involving a mismatch in Number, where an additional character was added in the middle.

Examples of our experimental sentences are given in (11) and (12), with the paired pictures reported in **Figures 13–16**.

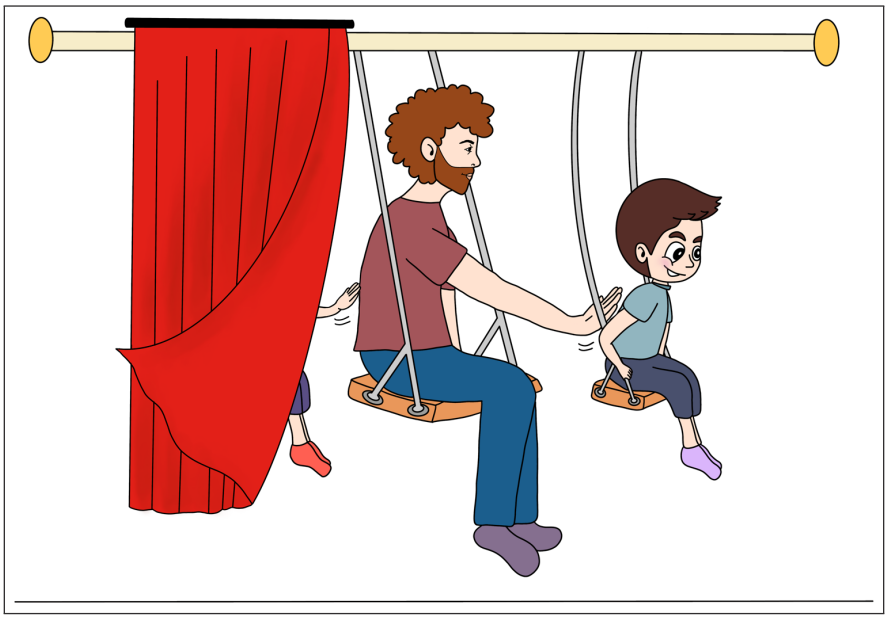


Figure 13: No-Scenario for (11a).

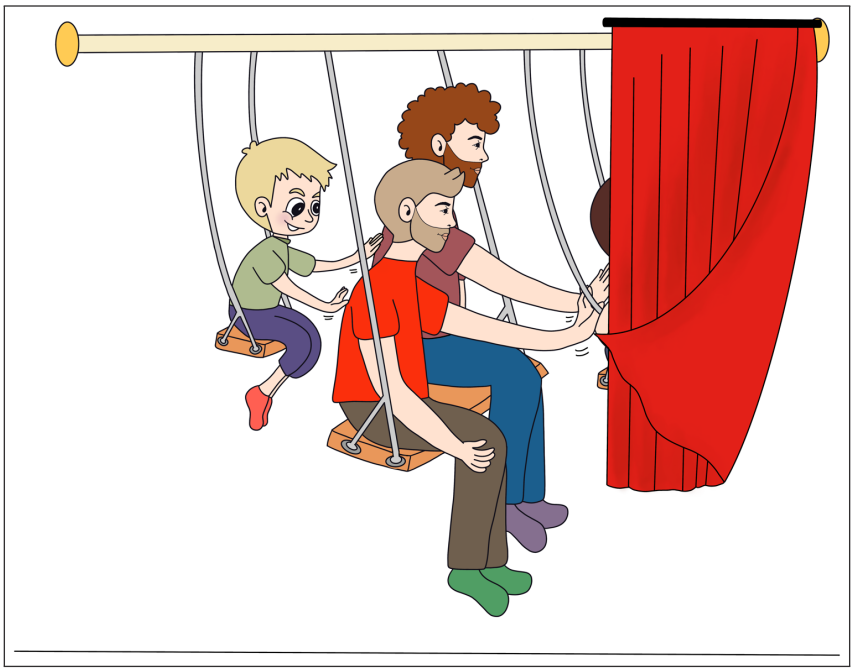


Figure 14: Yes-Scenario for (11b).

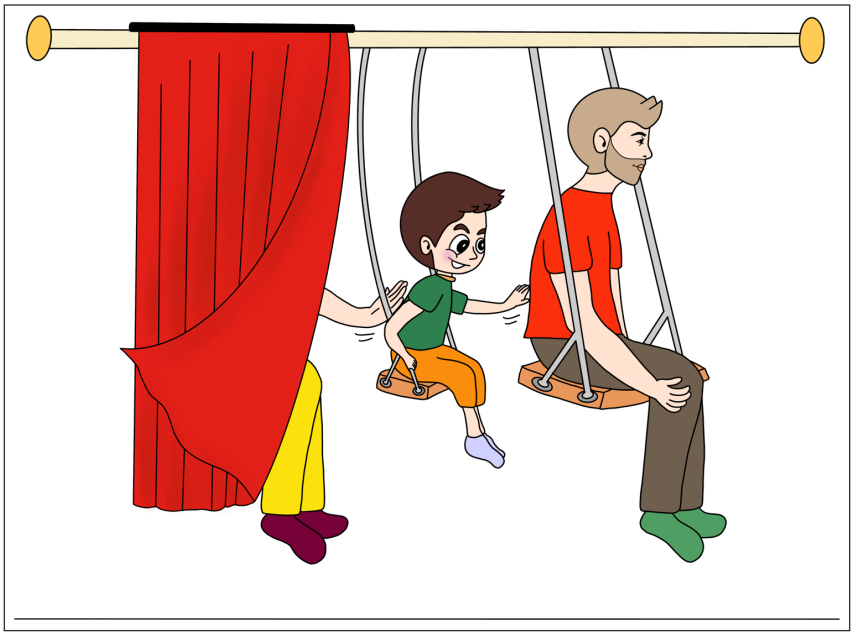


Figure 15: Yes-Scenario for (12a).

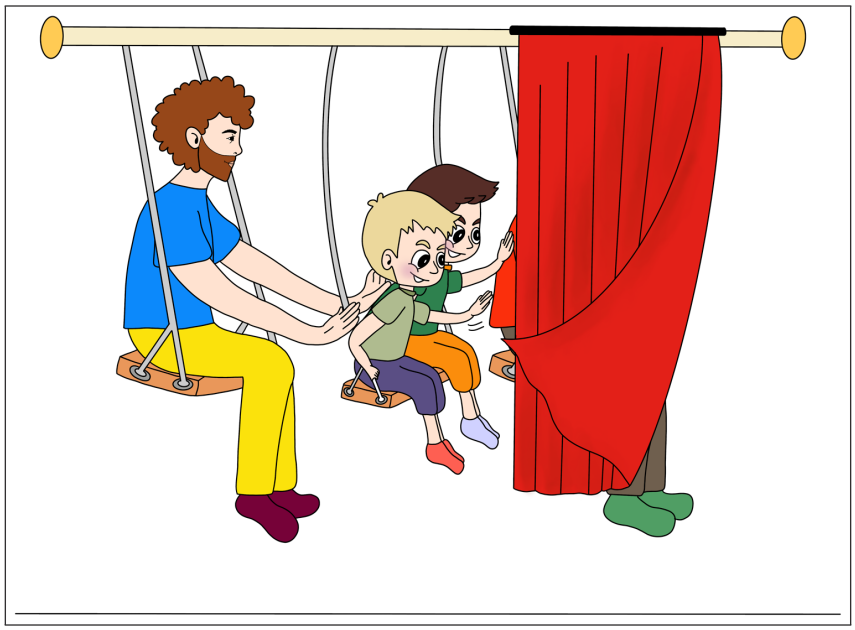


Figure 16: No-Scenario for (12b).

(11) SUBJECT SLUICES: NO INTERVENTION

NUMBER MATCH

a. Posso vedere che un bambin-o spinge il signor-e, puoi
can.1SG see that a-M.SG child-M.SG push.3SG the-M.SG sir-M.SG can.2SG
vedere **qual-e** **bambin-o$_X$** <__$_Y$ spinge il signor-e>?
see which-SG child-M.SG push.3SG the-M.SG sir-M.SG
'I can see that a boy is pushing the gentleman, can you see which boy <__ is pushing the gentleman>?'

NUMBER MISMATCH

b. Posso vedere che un bambin-o spinge i signor-i, puoi
can.1SG see that a-M.SG child-M.SG push.3SG the-M.PL sir-M.PL can.2SG
vedere **qual-e** **bambin-o$_X$** <__$_Y$ spinge i signor-i>?
see which-SG child-M.SG push.3SG the-M.PL sir-M.PL
'I can see that a boy is pushing the gentlemen, can you see which boy <__ is pushing the gentlemen>?'

(12) OBJECT SLUICES: INTERVENTION

NUMBER MATCH: INCLUSION CONFIGURATION

a. Posso vedere che il bambin-o spinge un signor-e puoi
can.1SG see that the-M.SG child-M.SG push.3SG a-M.SG sir-M.SG can.2SG
vedere **qual-e signor-e$_{X\,[+Q,+NP,+SG]}$** **< il bambin-o$_{Z\,[+NP,+SG]}$**
see which-SG sir-M.SG the-M.SG child-M.SG
spinge **__$_{Y\,[+Q,+NP,+SG]}$ >**?
push.3SG
'I can see that the boy is pushing a gentleman, can you see which gentleman < the boy is pushing __ >?'

NUMBER MISMATCH: INTERSECTION CONFIGURATION

b. Posso vedere che i bambin-i spingono un signor-e puoi
can.1SG see that the-M.PL child-M.PL push.3PL a-M.SG sir-M.SG can.2SG
vedere **qual-e signor-e$_{X\,[+Q,+NP,+SG]}$** **< i bambin-i$_{Z\,[+NP,+PL]}$**
see which-SG sir-M.SG the-M.PL child-M.PL
spingono **__$_{Y\,[+Q,+NP,+SG]}$ >**?
push.3PL
'I can see that the boys are pushing a gentleman, can you see which gentleman < the boys are pushing __ >?'

The task comprised 40 trials, starting with the same 4 warm-ups as in Experiment 1 and adopting the same controls with argument reversal used in Experiment 1.[17]

3.3.3 Results

3.3.3.1 Statistical analyses

Our results are reported in **Figure 17**. As in Experiments 1 and 2, adults performed at ceiling in all conditions, and children showed an overall above-chance performance, with accuracy increasing with age.

Figure 17 further suggests the presence of a subject > object asymmetry in the sluices, mirroring the trend of the previous experiments: altogether, children gave more correct responses for subject sluices than for object sluices. Nevertheless, such an asymmetry seems to be mitigated in the presence of Number mismatch in object sluices. Specifically, Italian preschoolers performed better in object sluices with Number Mismatch than in those with Number Match (61.3% *vs*. 54%

[17] Recall that the control stimuli employed in Experiment 2 were also balanced with respect to the Lexical Restriction for consistency with the test stimuli. In half of the cases, they featured the bare wh-element chi, while in the other half, they featured the lexically restricted wh-element *quale + NP*.

at age 3, 76.9% *vs.* 60.3% at age 4, 90.2% *vs.* 76.4% at age 5). In stark contrast, the proportion of correct responses in subject sluices is similar across the two different Number conditions (72.7% *vs.* 74% at age 3, 81.4% *vs.* 84.6% at age 4, 92.5% *vs.* 89.7% at age 5).

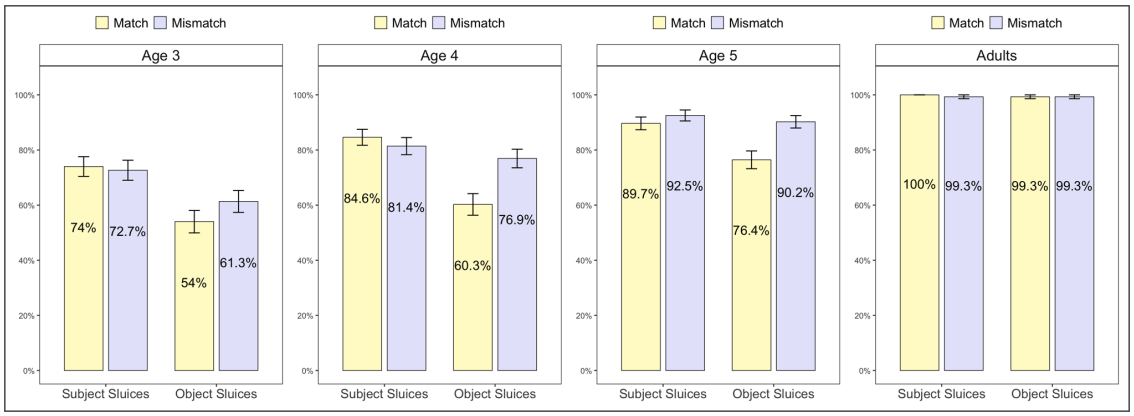


Figure 17: Response accuracy (%) by Extraction and Number for each Age Group.

To statistically verify the results observed in **Figure 17**, participants' responses were analyzed using linear mixed-effects logistic regression models (GLMMs) in R (R Core Team 2023). The analyses were conducted using the same statistical tools outlined for Experiments 1 and 2. As for predictors, we included Age (4 levels: Age 3, Age 4, Age 5, Adults), Extraction Site (2 levels: Subject, Object), Number (2 levels: Match, Mismatch), Scenario (2 levels: Yes-Scenario, No-Scenario), also specifying their interactions. We also specified random intercepts for Participants and Items. The estimates of the fixed effects of the model that best fitted our data are reported in **Table 10**.

	β	SE	z value	*p*
Intercept	2.432	0.174	13.974	<.001
Age (Children *vs.* Adults)	4.178	0.597	6.994	<.001
Age (Children Age 3 *vs.* Age 4)	1.318	0.249	5.296	<.001
Age (Children Age 4 *vs.* Age 5)	1.498	0.259	5.787	<.001
Scenario	–0.134	0.159	–0.844	.399
Extraction Site	–0.776	0.160	–4.841	<.001
Number	0.331	0.160	2.071	.038
Extraction Site * Number	0.729	0.320	2.281	.023

Table 10: Output of the mixed effect logistic regression model (Full Model Summary: AIC = 1950.4; BIC = 2008.6; LogLik = –965.2; Dev = 1930.4).

The model revealed significant main effects of Age, Extraction Site and Number, as well as the two-way interaction Extraction Site*Number.

The first Age contrast (Children *vs*. Adults) shows that children's correct responses are significantly lower than adults', who performed at ceiling in all conditions ($\beta = 4.18$, $SE = 0.60$, $z = 7.00$, $p < .001$). As in previous experiments, the proportion of target responses increase with age: 3-year-olds differ from 4-year-olds ($\beta = 1.32$, $SE = 0.25$, $z = 5.30$, $p < .001$), and 4-year-olds differ from 5-year-olds ($\beta = 1.50$, $SE = 0.26$, $z = 5.79$, $p < .001$).

Additionally, the main effect of Extraction Site confirms the asymmetry depicted in **Figure 17**: subject sluices are better comprehended than object sluices, as shown by a significantly lower proportion of correct answers for the latter ($\beta = –0.78$, $SE = 0.16$, $z = –4.84$, $p < .001$).

Eventually, the model also detected a significant main effect of Number ($\beta = 0.33$, $SE = 0.16$, $z = 2.07$, $p = .038$), indicating that Italian preschool children provided a higher number of correct responses in the sluices with Number mismatch than in those with Number match. In this respect, the significant Extraction Site*Number interaction further indicates that children responded more accurately to object sluices with Number mismatch ($\beta = 0.73$, $SE = 0.32$, $z = 2.28$, $p = .023$), while the accuracy rate in subject sluices is not affected by the Number condition, as further confirmed by post-hoc Tukey's tests ($\beta = 0.03$, $SE = 0.24$, $z = 0.14$, $p = .99$).

3.3.3.2 Individual analyses

To verify the consistency of our statistical results within participants, an individual analysis was conducted, consisting of two subparts as in Experiment 2. First, we examined the effect of Extraction Site, focusing on whether the subject > object asymmetry holds within each individual's acquisition path. To this end, we counted the number of correct responses across the two conditions related to the variable Extraction Site (Subject, Object). With a threshold of 8/12 correct responses to define a structure as acquired, participants were classified into three response patterns: (i) No acquisition of sluicing, comprising children who have not yet acquired either subject or object sluices (Pattern 1), (ii) Acquisition of subject sluices, including children who correctly comprehend sluices but still exhibit difficulties with object sluices (Pattern 2); (iii) Acquisition of both subject and object sluices, including children who manage both sentence types (Pattern 3). Notably, the fourth logical possibility, i.e., having acquired object sluices but not subject sluices (Pattern 4), was again not instantiated by any participant.

The second subpart of the analysis focused on the two-way interaction Extraction Site*Number, splitting Pattern 3 into two sub-conditions based on the Number manipulation. In this sub-analysis, since there were 6 stimuli for each condition, a structure type was defined as acquired with 5/6 correct responses, as indicated by a binomial test. Accordingly, two sub-groups within Pattern 3 emerged: (i) Acquisition of object sluices involving a number mismatch configuration, including children who correctly comprehended object sluices involving

a plural subject DP, but not those in which the subject DP, being singular, match in the Number specification with the wh-object (Pattern 3A); (ii) Acquisition of both object sluices involving a Number mismatch configuration and those involving a Number match configuration, encompassing children who performed above-chance in both types of object sluices, that is not only when the two DPs involved in the stimuli mismatched in Number, but also when they both were specified as singular with respect to the Number feature (Pattern 3B).

Once again, the two other possibilities besides Pattern 3A and Pattern 3B would have been (i) the reverse of Pattern 3A, i.e. having acquired object sluices with a Number match but not those with a Number mismatch, henceforth Pattern 3C; (ii) the NAC (Nearly-Above Chance) Pattern, where participants scored exactly 4/6 in both object sluices with Number match and in those with Number mismatch, yielding 8/12 correct responses overall. While no participants exhibited Pattern 3C, as predicted by fRM, two 3-year-olds, one 4-year-old, and one 5-year-old exhibited the NAC Pattern.

The stepwise acquisition path that emerges putting together the different patterns identified, roughly correlated with age (Fisher's Exact Test with Monte Carlo method, $p < .001$)[18], is depicted in **Table 11**.[19]

	Pattern 1 [–SUBJ,–OBJ]	**Pattern 2** [+SUBJ,–OBJ]	**Pattern 3** [+SUBJ, +OBJ]			**Pattern 4** [–SUBJ, +OBJ] (OUTLIERS)
			Pattern 3A [+MM_{OBJ},–M_{OBJ}]	**Pattern 3B** [+MM_{OBJ}, +M_{OBJ}]	**Pattern 3C** [–MM_{OBJ}, +M_{OBJ}] (OUTLIERS)	
Age 3	3/25 (12.0%)	13/25 (52.0%)	1/25 (4.0%)	6/25 (24.0%)	0/25 (0.0%)	0/25 (0.0%)
Age 4	1/26 (3.8%)	8/26 (30.8%)	8/26 (30.8%)	8/26 (30.8%)	0/26 (0.0%)	0/26 (0.0%)
Age 5	0/29 (0.0%)	2/29 (6.9%)	10/29 (35.7%)	16/29 (55.2%)	0/29 (0.0%)	0/29 (0.0%)
Adults	0/24 (0.0%)	0/24 (0.0%)	0/24 (0.0%)	24/24 (100.0%)	0/24 (0.0%)	0/24 (0.0%)

Table 11: Acquisition path: frequency and percentages for each pattern by Age.

Numerically, Pattern 1 is instantiated only by some residual younger children, while the opposite pole of the path, i.e. Pattern 3B, is mostly found among the older ones, as well as all the adults. As for the intermediate patterns, Pattern 2 is mostly exhibited by children aged 3 and 4 (FET-MC, $p = .003$, Bonferroni-corrected), whereas Pattern 3A is mostly instantiated by those aged 4 and 5 (FET-MC, $p = .032$, Bonferroni-corrected). This suggests a four-stage acquisition path: (i) STAGE I, where children do not comprehend either subject or object sluices; (ii) STAGE II, where children comprehend subject sluices but not object sluices; (iii) STAGE III, where children

[18] Statistical analyses on the counts were performed as detailed in footnote 14, using Fisher's Exact Test with Monte Carlo method (hereafter FET-MC).

[19] As in Experiment 2, we leave NAC Pattern aside, as it is uninformative for our purposes.

comprehend both subject sluices and object sluices involving a Number mismatch; (iv) STAGE IV, where children comprehend both subject sluices and object sluices, both with and without a Number mismatch.

3.3.4 Interim conclusion

To verify whether there is a fRM effect in sluicing, Experiment 3 compared the intersection and the inclusion set-relations of the distinctness hierarchy. We manipulated the Number feature specification in the DPs, maintaining the wh-remnants lexically identical across all conditions. Hence, two configurations were tested: Number match condition (i.e., both the DPs were singular), yielding an inclusion relation, and Number mismatch condition (i.e., the wh-remnant was singular, while the other DP was plural), yielding an intersection relation.

Results replicate the subject > object asymmetry previously found and, more crucially, show that children's difficulties with object sluices are mitigated when the wh-element and the silent DP subject mismatched in Number, namely in the presence of an intersection configuration, in line with the predictions of fRM. Since the wh-phrase was a singular *quale + NP* in all our stimuli, to our eyes, no other explanations seem compatible with the gap performance detected in matched *vs*. mismatched object sluices.

4 General discussion

4.1 Featural relativized minimality under sluicing

Our three experiments investigated the comprehension of elliptical indirect wh-questions by Italian preschool children, asking whether the locality principle of fRM and its related distinctness hierarchy regulate the acquisition of sluicing, as it does in other lexically realized A′-dependencies. Under the assumption that sluices involve a full-fledged indirect wh-question, which is structurally isomorphic to its antecedent but undergoes PF-deletion, if fRM is a locality principle operating in the syntax, it should constrain the acquisition of sluiced indirect wh-questions.

Accordingly, Experiment 1 compared children's comprehension of elliptical and non-elliptical indirect wh-questions to assess whether parallel acquisition paths effectively emerge. Results showed that, although younger children face greater difficulties with sluiced sentences —arguably due to the cost associated with ellipsis (see Section 3.1.4)— the acquisition of both lexicalized and elided interrogative wh-questions proceeds in a comparable fashion. As a matter of fact, subject-extracted sentences are easier than object-extracted sentences independently of the lexicalization of the embedded interrogative. This asymmetry may reflect a fRM-effect: in subject-extracted sentences, the moved wh-subject does not encounter an intervening element in its movement path to Spec,QembP of the indirect interrogative (13a), whereas in object-extracted sentences

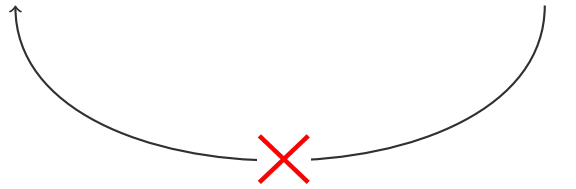
the subject DP intervenes in the chain of the moved wh-object (13b), thereby challenging children's comprehension.

(13) NO INTERVENTION

a. … [$_{Q_{emb}P}$ quale bambina [$_{TP}$ <quale bambina> pettina la signora]]
which child <which child> combs the lady
X <Y>

INTERVENTION

b. … [$_{Q_{emb}P}$ quale signora [$_{TP}$ la bambina pettina <quale signora>]]
which lady the child combs <which lady>
X Z <Y>



Although the subject > object asymmetry is compatible with explanations other than fRM (Section 3.1.4), its presence in both sluiced and non-elliptical wh-interrogatives suggests that the two structures are subject to the same constraints.

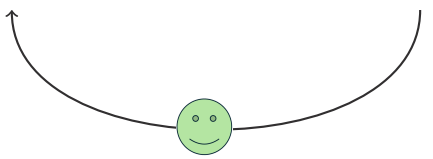
The other two experiments focused on sluices, testing the role of fRM with respect to two set-relations on the distinctness hierarchy, i.e. disjunction and intersection. To this end, we manipulated Lexical Restriction and Number, both of which are involved in the definition of syntactic positions and are therefore relevant for the computation of fRM (see Introduction).

Experiment 2 tested the disjunction set-relation, comparing it with the inclusion relation. We verified children's comprehension of subject- and object-extracted sluiced sentences manipulated for the lexical restriction on the wh-remnants. Using either the lexically specified wh-phrase *quale + NP* or the bare wh-pronoun *chi*, we obtained match and mismatch configurations with respect to the lexical restriction between the wh-element and the other DPs, which were always lexically restricted. According to fRM, we expected subject sluices to be comprehended more accurately than object ones and, among object sluices, the mismatch configuration to improve comprehension. Results confirmed that children's accuracy rate is higher in subject sluices than in object sluices, replicating the asymmetry. Additionally, children's difficulties with object sluices

were alleviated when involving the bare wh-element *chi* (i.e. lexical mismatch configuration) rather than the lexically specified wh-phrase *quale+NP* (i.e. lexical match configuration). Notably, object sluices with a lexical mismatch involve a disjunction configuration (14a). Conversely, in object sluices with a lexical match, an inclusion configuration arises, as the featural specification of the intervening subject DP is included in the featural specification of the moved wh-object (14b).

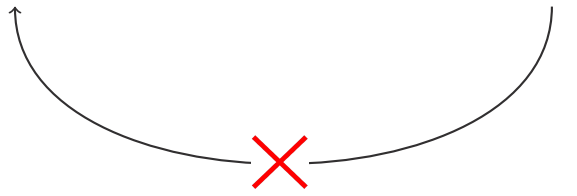
(14) DISJUNCTION CONFIGURATION

a. … [$_{Q_{emb}P}$ chi [$_{TP}$ il bambino lava <chi>]]
who the child washes <who>
[+Q] [+NP] [+Q]
X Z <Y>



INCLUSION CONFIGURATION

b. … [$_{Q_{emb}P}$ quale signore [$_{TP}$ il bambino lava <quale signore>]]
which sir the child washes <which sir>
[+Q, +NP] [+NP] [+Q, +NP]
X Z <Y>



Whereas disjunction configurations are less problematic for children, dependencies involving inclusion configurations are penalized by fRM (see Introduction).

That said, we could not exclude the possibility that children's difficulties with lexically restricted object sluices may stem from the interplay of both the independent processing-related difficulty of object sluices on one side, and the additional complexity with *quale+NP* as the remnant on the other (see Section 3.2.4).

To further verify the role of fRM with respect to the distinctness hierarchy, Experiment 3 tested the intersection set-relation, comparing it with the inclusion relation. We maintained the

wh-remnants identical across all conditions, using the lexically specified singular form *quale + NP*, while manipulating Number in the other DPs involved in the stimuli. According to fRM, we expected a subject > object asymmetry and an improvement in the comprehension of object sluices with a Number mismatch configuration. Results confirmed the subject advantage. Moreover, Italian children's difficulties with object sluices were mitigated when the wh-object and the DP subject mismatched in Number, while this amelioration effect did not appear in subject sluices.

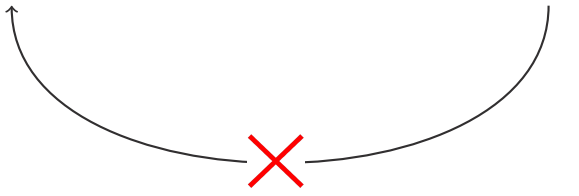
Without the possibility of capturing these findings through the differences between the wh-remnants —as it may have been the case for Experiment 2— our data demonstrate that the acquisition of sluices is effectively constrained by fRM. Indeed, object sluices with a mismatch in Number involve an intersection configuration, as the featural specification of the intervening subject DP intersects with the featural specification of the moved wh-object (15a), thereby making these sluices less problematic for children. In sharp contrast, when the subject and the object DPs match with respect to the Number feature, the featural specification of the intervening subject constitutes a subset of the featural specification of the moved wh-object, giving rise to an inclusion configuration (15b). As a result, these sluices are more difficult for children.

(15) INTERSECTION CONFIGURATION

a. … [$_{Q_{emb}P}$ quale signore [$_{TP}$ i bambini spingono <quale signore>]]
which sir the children push <which sir>
[+Q, +NP, +SG] [+NP, +PL] [+Q, +NP, +SG]
X Z <Y>

INCLUSION CONFIGURATION

b. … [$_{Q_{emb}P}$ quale signore [$_{TP}$ il bambino spinge <quale signore>]]
which sir the child pushes <which sir>
[+Q, +NP, +SG] [+NP, +SG] [+Q, +NP, +SG]
X Z <Y>



No amelioration effect due to Number mismatch arises in subject sluices, as expected under fRM, since no intervening element is crossed by the subject wh-remnant. These results are further corroborated by the individual analyses, which point towards postulating four incremental acquisition stages. First, children do not comprehend elliptical indirect wh-questions, possibly because they cannot simultaneously manage all the mechanisms required to handle sluicing (No Acquisition Stage, see Section 3.1). Secondly, children comprehend subject sluices, where no intervening element is present, but still exhibit difficulties with object sluices (No Intervention Stage). Subsequently, children start comprehending object sluices, but only when the featural specification of the intervening subject intersects with that of the wh-object (Intersection Configuration Stage). Finally, they do also comprehend object sluices where the fRM-relevant features of the intervening subject constitute a subset of the fRM-relevant features of the wh-object, thus mastering intervention effects (Inclusion Configuration Stage).

Alongside featural Relativized Minimality, it is worth considering whether our results are also compatible with domain-general psycholinguistic accounts of locality, such as Similarity-Based Interference (SBI; Gordon et al. 2001 et seq., Gerard et al. 2017, a.o.), which posits that interference arises when the retrieval of a DP at the gap is linearly disrupted by another DP with overlapping cues, with parsing difficulty increasing as a function of the number of shared features. While some psycholinguistic accounts acknowledge the psychological reality of null elements, including pronouns and traces (McElree & Bever 1989, a.o.), to the best of our knowledge, none have related it to the phenomenon of interference. That is, to date, SBI has not predicted interference effects to emerge when the intervener is not overtly realized, as in sluicing. In fact, much of the processing literature on ellipsis argues that elided material is recovered via a "cost-free" mechanism (Frazier & Clifton Jr 2005, a.o.), and thus predicts no subject > object asymmetry in sluicing. What is more, adult processing studies (e.g., Harris 2015) have reported an object advantage, arguably due to the shorter linear distance between the overt wh-remnant and the more local object correlate.

At first glance, our finding of a subject advantage in children may seem at odds with these results. However, we argue that children's difficulty with structural intervention in A′-dependencies may obscure potential linear locality effects between the remnant and its antecedent correlate, which only emerge once children are capable of simultaneously (i) recovering the elided material and (ii) A'-moving a DP over another DP that overlaps in fRM-relevant morphosyntactic features.

While our study was not intended to distinguish between competing theoretical frameworks, we believe that explaining the present findings poses a challenge for current domain-general models of sentence processing. These accounts would need to be extended with more precise formalizations of parsing mechanisms —particularly those capable of handling syntactically active but unpronounced elements, such as elided subjects in sluicing. In contrast, grammar-based

approaches like fRM offer a formally grounded account of such phenomena, offering valuable insights for refining psycholinguistic models of comprehension.

Indeed, fRM allows us to capture children's difficulties not merely as limitations of processing capacity, but as the result of applying the same locality principle that operates in adult grammar, albeit more stringently. In adults, fRM violations give rise to graded judgments of acceptability rather than outright ungrammaticality, suggesting that locality is not an all-or-nothing constraint, but one that admits degrees of acceptability depending on featural overlap between X and Z. Configurations that yield mild degradation in adults result in comprehension failure at certain developmental stages. Just as crosslinguistic variation shows that different languages enforce locality constraints to different degrees (see Rizzi 2018 and references therein), child grammar can be seen as an early, more conservative instantiation of fRM, which becomes more lenient with development.

Having demonstrated that the modulation of the featural distinctness between the wh-remnant and an intervening phonologically silent element effectively reduces children's difficulties with object sluices according to the distinctness hierarchy, as predicted by fRM, we conclude that fRM operates in sluicing, being thus a grammatical principle independent of lexicalization.[20]

4.2 The structure at the ellipsis site

Orthogonally, our results a fortiori support our underlying structural assumption to sluicing, i.e. sluices are underlyingly wh-question CPs (Merchant 2001). Indeed, the detection of intervention effects, modulated according to the hierarchy of featural similarity between the wh-phrase and the intervening subject DP, necessarily implies the presence of an intervener along the movement path of the wh-phrase, and thus of a full-fledged CP structure in the syntax.

Moreover, we believe that the findings from Experiment 3 corroborate another aspect of Merchant's hypothesis, namely that the sluiced CP is isomorphic to its antecedent as in (2), here repeated as (16).

(16) Gianni mangia qualcosa, ma non so cosa <Gianni mangia _>
John eat.3SG something but not know.1SG what John eat.3SG
'John eats something, but I don't know what <John eats _>'

[20] Future research could investigate whether the order of intervention configurations, as formalized in the distinctness hierarchy, is genuinely reflected in children's performance. While we found that children performed better with disjunction and intersection configurations relative to inclusion, fRM also predicts better performance with disjunction than with intersection. Although our results numerically align with this prediction, the difference between disjunction and intersection did not reach statistical significance when data from the two experiments were combined. We believe this lack of significance may be due to different groups of children participating in each experiment, which can reduce the reliability of cross-experimental comparisons and make subtle differences harder to detect.

In addition to (16), two other competing hypotheses have been advanced in the theoretical literature, both arguing for the existence of non-isomorphic underlying wh-structures for at least some sluices (e.g., Rodrigues et al. 2006; Barros et al. 2014). Accordingly, sluices involve an underlying copular or cleft wh-question. Let us now evaluate these two hypotheses in light of fRM and our findings. Under Moro's (1997) analysis of copular clauses , fRM should not apply since the wh-phrase and the elided DP are merged in a small clause and no c-command relation holds between them. If our sluices were to involve an underlyingly copular structure, the subject advantage detected in our experiments might be accounted for by appealing to the maintenance of the syntactic role of the wh-remnant with respect to its antecedent correlate (Sheldon 1974). In our subject sluiced stimuli, the wh-remnant predicates about the DP subject of the copular clause, and refers to the DP subject of the antecedent (17a). Conversely, in object sluices the wh-remnant still predicates about the subject of the copular, but refers back to the object DP of the antecedent clause (17b).

(17) a. […] un bambin-o lava il signor-e, […] chi/qual-e
a.M.SG child-M.SG wash.3SG the.M.SG sir-M.SG who/which-SG
bambin-o <è {*pro*/quest-o bambin-o}_>?
child-M.SG be.3SG *pro*/this-M.SG child-M.SG

b. […] il bambin-o lava un signor-e, […] chi/qual-e
the.M.SG child-M.SG wash.3SG a.M.SG sir-M.SG who/which-SG
signor-e <è {*pro*/quest-o signor-e}_>?
sir-M.SG be.3SG *pro*/this-M.SG sir-M.SG

To achieve the correct interpretation, an argument reversal is thus needed in (17b), making object sluices more demanding for children. This reasoning may apply to Experiment 1 as well as Experiment 2 with the additional complexity related to *quale+NP* to account for the distinction between sluices introduced by *quale+NP* and those with *chi* (see Section 3.2.4). However, if our sluices involve a copular structure, the performance gap found in Experiment 3 between Number mismatched and matched object sluices cannot be easily explained, as the wh-remnant remained constant across the different conditions. Hence, a copular structure underlying sluices seems inadequate for the sluices in Experiment 3, at least. Likewise, the hypothesis that sluices involve an underlyingly cleft structure should be dismissed. Italian cleft structures are constrained by fRM (Del Puppo et al. 2015) and thus our findings from all three experiments could be readily accounted for. However, since all our stimuli in Experiments 1 and 3 exclusively featured wh-remnants with *quale+NP*, an underlying cleft structure must be excluded because the lexically specified wh-phrase *quale+NP* cannot serve as the pivot of Italian clefts (Cardinaletti 2024).

Therefore, our findings are more compatible with the assumption that the tested sluiced questions involve an interrogative CP isomorphic to its antecedent in the syntax, as in (16).

Finally, our findings may be informative about the mechanism behind the phenomenon known as *Vehicle Change* proposed by Fiengo & May (1994) as part of their theory of ellipsis. Vehicle Change refers to a process whereby R-expressions inside ellipsis sites may be treated as pronominals. This would explain the acceptability of (18), where the elided direct object can be interpreted as coreferential with the c-commanding pronoun *he* in the clause above, thus circumventing a Principle C violation.

(18) Mary loves John$_i$ and he$_i$ thinks Sally does [$_{VP}$ <love him$_i$/*John$_i$>]

(Fiengo & May 1994: 220)

A reviewer rightly observes that the results of Experiment 2 are somewhat unexpected in light of Vehicle Change. Applying it to the elliptical clauses in our stimuli (10) yields the sentences in (19a) and (19b), respectively: in both cases the intervening subject DP *il bambino* ('the child') within the ellipsis site can be replaced by a pronoun.

(19) a. Posso vedere che il bambin-o lava un signore puoi
can.1SG see that the-M.SG child-M.SG wash.3SG a-M.SG sir-M.SG can.2SG
vedere **qual-e signore**$_{\mathbf{X}[+Q,+NP]}$ <**{pro/lui}$_Z$** lava $\_\_{Y[+Q,+NP]}$>?
see which-SG sir-M.SG {pro/lui} wash.3SG
'I can see that the boy is washing a sir, can you see which sir <he is washing _>?'

b. Posso vedere che il bambin-o lava qualcuno puoi vedere
can.1SG see that the-M.SG child-M.SG wash.3SG someone can.2SG see
chi$_{\mathbf{X}[+Q]}$ <**{pro/lui}$_Z$** lava $\_\_{Y[+Q]}$>?
who {pro/lui} wash.3SG
'I can see that the boy is washing someone, can you see who <he is washing _>?'

From this perspective, the asymmetry we observed in children's comprehension of Experiment 2 is puzzling: the assumed equivalence between R-expressions and pronouns within ellipsis sites should neutralize the crucial difference between (14a), i.e. inclusion, and (14b), i.e. intersection. At first glance, our results might thus suggest that Vehicle Change is not available to children. Still, we maintain that such a conclusion would not be warranted.

First, Vehicle Change is standardly assumed to apply at LF, whereas fRM is computed in the syntax (Rizzi 2018) and is thus not predicted to be impacted by this LF-mechanism. Put differently, the LF structures in (19) cannot undo the locality effects of (14).

Moreover, it is not obvious that Vehicle Change would apply to our stimuli in the first place. Indeed, if we assume that strict/sloppy readings (e.g., anaphor → pronoun) and negative/positive

polarity item alternations (e.g., someone → anyone) under ellipsis also fall within the scope of Vehicle Change, then we must assume that this process only applies when failing to do so would incur a grammatical violation. This was not the case in our test sentences; thus, (19) would not be derived.

Lastly, it is worth mentioning that Vehicle Change has faced numerous empirical and theoretical challenges in recent years (Aoun & Nunes 2007; Murphy & Müller 2021). For instance, Murphy & Müller (2021) propose a derivational account of ellipsis and binding that obviates the need for this ad-hoc principle. According to their analysis, ellipsis applies in a successive-cyclic fashion and the absence of Principle C effects in cases like (18) follows from the fact that the R-expression is no longer syntactically accessible at the point in the derivation in which the offending pronoun is merged. That is, the structure that would trigger a Principle C violation never arises. Under this view, the derivations in (19) would not be available to children or adults and our results would follow naturally.

Altogether, we conclude that the results of Experiment 2 provide empirical support for analyses that posit that nominal forms are identical to their antecedents under regular cases of sluicing, at least at the syntax level.

5 Conclusion

Much acquisition research has yielded support to the formal principle of fRM, testing different syntactic dependencies and manipulating various formal features. However, in all cases only structures involving lexical material were tested, leaving open whether fRM truly operates in the syntax or at PF. Our study aimed to verify precisely this, i.e. to what extent fRM is independent of lexicalization. We provided evidence for the subject > object asymmetry as well as for the distinctness hierarchy that modulates dependencies with intervention configurations in sluicing from a language, Italian, where, apart from NP-ellipsis (Tasinato & Sanfelici 2023; 2024), the acquisition of elliptical constructions has not been previously examined. Thus, our study demonstrates that fRM is a formal principle constraining syntactic dependencies independent of lexicalization.

Abbreviations

1 = first person, 2 = second person, 3 = third person, F = feminine, M = masculine, PL = plural, SBJV = subjunctive, SG = singular.

Data availability

All the experimental materials, including the statistical analyses conducted, are available here.

Ethics and consent

This study was exempt from ethical review according to the regulations of the University of Padua (see relevant documentation in the OSF repository here).

All experimental procedures were carried out in accordance with ethical principles for research involving human participants, in accordance with the Declaration of Helsinki, and with all relevant data protection regulations. Participants —or, in the case of children, their parents or legal guardians— provided informed consent prior to taking part in the studies. Data collection, management, and storage were conducted in compliance with the European General Data Protection Regulation principles (GDPR; Regulation EU 2016/679), the Code regulating the protection of personal data (Legislative Decree 196/2003 and subsequent amendments), as well as the Italian privacy regulations, including those of the University of Padua.

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Competing interests

The authors have no competing interests to declare.

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