The cost of silence: Processing constraints on elliptical strategies

Mengkai Wang*

Abstract. This study investigates the processing constraints on clausal ellipsis, specifically sluicing, to test the Processing Cost Hypothesis. Through a dual-task behavioral paradigm, the research manipulated Sluice Type and Cognitive Load. Results indicate that in Regular Sluicing, participants exhibit a strong preference for computationally efficient non-isomorphic evasion strategies under low cognitive load. However, this preference neutralizes under high load, suggesting that structural selection is a dynamic decision constrained by available executive resources. Conversely, Contrast Sluicing remains rigidly isomorphic regardless of load, as grammatical mandates override resource-based optimization. These findings support resource-rational models of language comprehension, proving that the human parser balances syntactic fidelity and processing economy only when the grammar permits structural optionality.

Keywords. clausal ellipsis; sluicing; cognitive load; processing cost; syntactic reconstruction

1. Introduction. The grammatical architecture of clausal ellipsis requires the structural parsing mechanism to reconstruct unpronounced syntactic material based on an explicit antecedent clause (Merchant 2001; van Craenenbroeck 2010). The resolution of sluicing constructions relies on a structural identity condition that forces a strict syntactic correspondence between the antecedent structure and the elided material (Chung et al. 1995; Ross 1969). Theoretical syntax models traditionally posit that this identity condition necessitates the projection of a fully articulated syntactic hierarchy within the ellipsis site (Frazier & Clifton 1998; Yoshida et al. 2013). The postulation of full structural projection encounters severe theoretical and empirical friction when evaluated against island constraints. The extraction of an interrogative pronoun out of an elided syntactic island frequently yields acceptable grammatical judgments, contradicting the established computational boundaries of syntactic movement operations (Phillips 2006; Sprouse et al. 2012). This asymmetry between pronounced and unpronounced island violations forms the empirical basis for the repair by ellipsis hypothesis, which posits that the deletion of the syntactic material neutralizes the morphosyntactic features responsible for the categorical island violation penalty (Merchant 2001; Abeill et al. 2020).

The universal application of the repair by ellipsis mechanism is actively contested by alternative theoretical models proposing non isomorphic resolution strategies (Barros et al. 2014; Gribanova 2013). Structural analyses of acceptable island violations under sluicing indicate that the human parser avoids the mandatory generation of complex island dependencies by assigning a structurally simplified source to the ellipsis site (Arregui et al. 2006). This evasion strategy relies on the formulation of a basic copular clause that satisfies the semantic requirements of the interrogative element without violating syntactic movement constraints (Frazier & Clifton 2005). Behavioral data tracking the real time resolution of sluicing confirm that parsers actively deploy these minimal structural representations to bypass extreme computational complexity (Martin & McElree 2008; Murphy 2016). The evasion algorithm operates effectively when the antecedent

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* I would like to thank the fellow scholars for their reviews and comments on this research. Authors: Mengkai Wang, Beijing Foreign Studies University (taylericy@bfsu.edu.cn).

clause provides sufficient semantic material to construct a licit non isomorphic correlate, proving that strict structural identity functions as a probabilistic processing preference rather than an absolute grammatical requirement (Barros et al. 2014). The bifurcation of sluicing resolution mechanisms is explicitly defined by the structural demands of the specific interrogative variant. Experimental investigations comparing regular sluicing constructions against contrast sluicing constructions reveal fundamentally distinct algorithmic parsing operations (Palaz et al. 2025; Griffiths & Liptk 2014). Regular sluicing environments tolerate structural divergence and exhibit a statistically robust preference for the non isomorphic evasion strategy (Barros et al. 2014). Contrast sluicing environments mandate absolute syntactic isomorphism to license the focal contrast between the interrogative phrase and its explicit correlate within the antecedent clause (Griffiths & Liptk 2014). This mandatory isomorphism restricts the available resolution options and forces the parser to execute the complex repair by ellipsis mechanism, regardless of the embedded island architecture (Palaz et al. 2025). The coexistence of these dual processing pathways generates a discrete syntax processing paradox. The parser possesses the processing capability to execute a complex island repair mechanism in the contrast condition, yet it actively defaults to a structurally reduced evasion algorithm in the regular condition.

The asymmetric deployment of these structural strategies requires an operational explanation grounded in cognitive resource allocation. The processing cost hypothesis specifies that the selection between structural identity and structural evasion is governed by principles of algorithmic optimization and working memory conservation (Gibson 1998; Levy 2008). The derivation of a fully articulated, island violating syntactic hierarchy demands high magnitude executive control and continuous memorial indexing. Furthermore, the activation based models of memory retrieval demonstrate that maintaining the complete feature set of the complex antecedent clause in an active state while attempting a full syntactic reconstruction places severe computational limits on the parsing architecture (Lewis & Vasishth 2005; Wagers et al. 2009). The alternative derivation of a reduced copular clause minimizes syntactic complexity, drastically reducing dependency length and lowering the absolute processing latency required for integration (Futrell et al. 2015). Capacity constrained models of human sentence comprehension dictate that the parser evaluates the computational cost of competing structures and defaults to minimal representations when the grammatical environment permits structural optionality (Just & Carpenter 1992; Hahn et al. 2020). This optimization protocol aligns directly with the good enough processing framework, which argues that the central executive consistently sacrifices strict syntactic fidelity to achieve semantic coherence while minimizing neurocognitive energy expenditure (Ferreira 2003; Karimi & Ferreira 2016).

The present research isolates the exact boundaries of the syntax processing interface by manipulating the availability of exogenous cognitive resources during real time ellipsis resolution. A controlled dual task behavioral paradigm was engineered to test the structural stability of the evasion strategy under induced working memory taxation. The core experimental framework crossed the structural sluice type parameter against varying magnitudes of a concurrent digit span retention task. The discrete dependent variables included the categorical selection of the syntactic source resolution strategy and the continuous temporal execution latency. If the preference for the non isomorphic evasion strategy operates as a static, hard wired grammatical reflex, the categorical choice distributions should remain strictly invariant across all cognitive load conditions, indicating that the structural evaluation bypasses central executive control (Yoshida et al. 2013; Paape et al. 2018). Conversely, if the evasion strategy represents an active, resource dependent heuristic computed exclusively to optimize cognitive economy, the application of extreme working memory load should systematically degrade the parser capacity to formulate the comparative non isomorphic structure. The statistical elimination of the evasion preference specifically under systemic cognitive strain would yield direct empirical proof that syntactic structural choice is a dynamic computational decision constrained entirely by the absolute operational limits of the human processing architecture.

2. Methodology. The research utilized a strictly controlled behavioral paradigm to investigate the syntax processing interface during ellipsis resolution. A factorial design was implemented to structure the experimental variables. The independent variables comprised a linguistic structural factor, designated as Sluice Type, and an extrinsic processing capacity factor, designated as Cognitive Load. The Sluice Type factor contained two categorical levels, identifying regular sluicing constructions and contrast sluicing constructions. The Cognitive Load factor was similarly bifurcated into a low cognitive load condition and a high cognitive load condition, operationalized through a concurrent secondary working memory task. The dependent variables measured during the experimental protocol included the categorical selection of the underlying syntactic source resolution strategy and the continuous temporal latency of this specific selection process. The source resolution strategy was operationalized as a binary two alternative forced choice between an isomorphic repair formulation and a non isomorphic evasion formulation.

2.1. PARTICIPANT SAMPLING AND CHARACTERISTICS. Data collection aimed at a sample of 30 adult native speakers to ensure stable syntactic processing representations. The final analytical sample generated an aggregate data set that included exactly 6,000 independent trial observations. To achieve this perfectly balanced statistical distribution, the participant pool performed a uniform number of experimental trials distributed equally across all designated factorial intersections. All individuals contributing to the dataset reported normal or corrected to normal visual acuity and an absolute absence of diagnosed cognitive or language processing deficits. Prior to the initiation of the experimental procedure, all participants provided documented informed consent in strict accordance with the established ethical guidelines governing human behavioral research at the host institution. Financial compensation was provided at a standard hourly rate corresponding directly to the temporal duration of the testing session.

2.2. STIMULI. The linguistic stimuli were engineered to isolate the specific processing mechanisms associated with sluicing resolution under varying structural demands, with an example set shown in (1). The base experimental items consisted of complex sentence structures containing a primary antecedent clause followed by an elliptical sluicing clause. These antecedent structures were specifically constructed to incorporate rigid syntactic island configurations. The presence of these structural boundaries forces the syntactic parser into a specific conflict state when attempting to reconstruct the unpronounced material in the subsequent sluicing clause. For the regular sluicing condition, the interrogative pronoun targeted a standard entity embedded within the island structure. For the contrast sluicing condition, the interrogative pronoun necessitated a direct semantic and syntactic contrast with a specific correlate explicitly present in the antecedent clause.

(1) a. Regular Sluicing Condition:
The administrative council dismissed the supervisor who hired a specific technician, but the department director does not know who.

Isomorphic Repair Continuation: ...who the administrative council dismissed the supervisor who hired.
Non-isomorphic Evasion Continuation: ...who it was.

b. Contrast Sluicing Condition:
The administrative council dismissed the supervisor who hired a specific technician, but the department director does not know which other technician.
Isomorphic Repair Continuation: ...which other technician the administrative council dismissed the supervisor who hired.
Non-isomorphic Evasion Continuation: ...which other technician it was.

2.3. EXPERIMENTAL PROCEDURE. The experimental protocol was administered in a sound attenuated laboratory environment to minimize external sensory interference. The stimulus presentation sequence was programmed and executed using specialized behavioral data collection software. Participants were seated at a standardized fixed distance of sixty centimeters from a high refresh rate display monitor. The ambient lighting in the testing chamber was maintained at a constant low level across all experimental sessions. Each trial sequence commenced with a central fixation cross presented for five hundred milliseconds to standardize visual attention and stabilize ocular positioning. Following the fixation interval, the numeric sequence corresponding to the assigned cognitive load condition was displayed sequentially at the center of the screen. Each digit appeared for one thousand milliseconds, separated by an inter stimulus interval of two hundred milliseconds. Subsequently, a secondary masking screen was presented for five hundred milliseconds to prevent lingering visual afterimages. The base linguistic stimulus was then presented centrally on the screen using a self paced reading paradigm to ensure complete semantic integration prior to the decision phase. Upon the completion of the base sentence reading phase, the two continuation options representing the repair and evasion strategies were displayed simultaneously on the left and right sides of the lower visual field. The lateral spatial positioning of the specific continuation types was fully counterbalanced across all trials to eliminate localized spatial selection bias. Participants were instructed to perform a forced choice acceptability judgment, selecting the continuation that formed the most natural grammatical completion of the preceding elliptical clause using designated response keys on a standardized input device.

2.4. DATA ACQUISITION. The primary data acquisition system recorded the binary categorical selection executed by the participant via the dedicated response mechanism. The temporal latency of the decision process, operationalized as reaction time, was measured continuously from the exact onset of the visual presentation of the continuation options until the physical registration of the motor response. The temporal measurement recorded values in milliseconds and was synchronized via a hardware interrupt protocol with the monitor vertical blanking interval to ensure absolute timing accuracy. To maintain the structural integrity of the temporal dataset, a strict dual phase exclusion protocol was applied to the raw data output prior to any statistical modeling procedures. The initial phase involved the absolute truncation of trials where the reaction time fell outside predefined biologically plausible boundaries, specifically filtering values below two hundred milliseconds or exceeding three thousand milliseconds. The secondary phase applied a dynamic statistical threshold, whereby reaction times exceeding three standard deviations from the individualized condition mean for each specific participant were categorized as localized processing anomalies and completely removed from the temporal analysis matrix. The application of these rigorous exclusion parameters ensured that the final dataset analyzed during the structural modeling phase accurately reflected standard cognitive processing mechanisms rather than attentional lapses or anticipatory motor responses.

3. Results. The analytical procedures were executed on a total dataset consisting of 6,000 independent trial observations. The experimental paradigm was structured as a fully crossed two-by-two factorial design, producing four distinct condition categories. The independent variables under manipulation were Sluice Type, designated as Regular Sluicing and Contrast Sluicing, and Cognitive Load, designated as Low Cognitive Load and High Cognitive Load. The trial distribution achieved exact balance, resulting in 1,500 observations for each of the four experimental intersection points. Two dependent variables were recorded during the trials. The primary dependent variable was the binary categorical selection of the non-isomorphic evasion strategy versus the isomorphic repair strategy, executed during the forced-choice acceptability judgment phase. The secondary dependent variable was the reaction time, measured continuously in milliseconds, defining the latency from stimulus onset to the participant motor response.

3.1. ATEGORICAL SELECTION. The descriptive statistical parameters for the proportion of evasion strategy selections are documented in Table 1. The data aggregated within this matrix represent the unadjusted mean probabilities of participants selecting the evasion source. Within the Regular Sluicing condition administered under Low Cognitive Load, the observed proportion of evasion choices was 0.811. The standard error associated with this specific mean was 0.010. The bounds of the ninety-five percent confidence interval for this condition were established at 0.79 for the lower limit and 0.83 for the upper limit. This localized data distribution indicates a dominant frequency of evasion strategy selection when cognitive resources remain untaxed by the secondary memory span task.

Within the Regular Sluicing condition subjected to High Cognitive Load, the proportion of evasion choices exhibited a numerical reduction, stabilizing at 0.473. The standard error for this condition was 0.013, with a ninety-five percent confidence interval bounded by 0.45 and 0.50. The absolute statistical difference between the Low and High Cognitive Load states specifically within the Regular Sluicing parameter equated to a 0.338 negative shift in the probability of selecting the evasion source. The upper boundary of the confidence interval for the High Cognitive Load condition intersects the 0.50 mathematical coordinate, which demarcates the theoretical threshold of chance selection within a binary two-alternative forced-choice framework.

The response topography within the Contrast Sluicing condition manifested a different statistical pattern. Under Low Cognitive Load, the measured proportion of evasion selections was 0.092. The standard error for this mean was 0.007, and the ninety-five percent confidence interval extended from 0.08 to 0.11. This outcome quantifies a stringent dispreference for the evasion strategy in this grammatical context. Under High Cognitive Load, the proportion of evasion choices within the Contrast Sluicing condition displayed a minor positive deviation to 0.113. The standard error for this specific measurement was 0.008, flanked by confidence interval limits of 0.10 and 0.13. The calculated absolute difference between the load conditions for Contrast Sluicing was an increase of 0.021. The confidence intervals for the Low and High load states within the Contrast Sluicing parameter exhibit a fractional margin of overlap, and both intervals reside firmly at the extreme lower boundary of the probability matrix.

Sluice Type	Load	N	Evasion Prop.	Evasion SE	RT Mean	RT SD	Evasion 95% CI
Contrast	High	1500	0.113	0.008	676.1	138.9	[0.10, 0.13]
Contrast	Low	1500	0.092	0.007	681.5	135.2	[0.08, 0.11]
Regular	High	1500	0.473	0.013	679.0	138.0	[0.45, 0.50]
Regular	Low	1500	0.811	0.010	674.8	136.9	[0.79, 0.83]

Table 1. Descriptive statistics for strategy choice and reaction time

3.2. STRATEGY PREFERENCES. Figure 1 provides the visual coordinate mapping of the descriptive statistics corresponding to the evasion strategy preference. The ordinate axis defines the proportion of evasion choice, scaled continuously from the absolute zero baseline to the 1.0 maximum limit. The abscissa axis categorically segregates the data points by Sluice Type. The internal structural color coding differentiates the Cognitive Load parameter, deploying pink vertical bars for the Low Cognitive Load condition and light blue vertical bars for the High Cognitive Load condition. Error bars affixed to the superior terminal edge of each bar graph represent the standard error of the mean derived from Table 1. A horizontal dashed line bisects the plot exactly at the 0.50 coordinate on the ordinate, formally denoting the chance level of strategy selection.

The spatial configuration of the graphical elements in Figure 1 corresponds to the numerical data structure. The pink bar indexing Regular Sluicing under Low Cognitive Load occupies the upper quartile of the visual field, positioned with a high degree of separation from the chance threshold line. The adjacent light blue bar, indexing Regular Sluicing under High Cognitive Load, terminates at a coordinate marginally below the horizontal dashed line, visually quantifying the reduction of the choice proportion to chance-level probability. In the secondary spatial domain on the right side of the abscissa, both vertical bars corresponding to Contrast Sluicing are restricted to the bottom decile of the plot area. This spatial restriction confirms the generalized rejection of the evasion strategy in the contrast condition, invariant of the secondary cognitive task application.

Figure 2 isolates the mathematical interaction effect through an independent line plot coordinate system. The ordinate axis retains the proportion of evasion choice scalar measurement. The abscissa axis maps the categorical transition between the two levels of Sluice Type. Data points are demarcated by disparate marker shapes and line configurations: circular markers intersected by a solid line define the Low Cognitive Load condition, and square markers intersected by a dashed line define the High Cognitive Load condition. Error bars encapsulate the standard errors vertically around each point estimate. The defining structural characteristic of this plot is the non-parallelism exhibited by the intersecting lines. The solid line designating Low Cognitive Load originates at an elevated spatial coordinate for Regular Sluicing and descends to a minimal coordinate for Contrast Sluicing. The dashed line designating High Cognitive Load originates near the median coordinate of the vertical axis for Regular Sluicing and descends to closely approximate the terminus of the solid line at the Contrast Sluicing coordinate. The spatial divergence of the coordinates on the left hemisphere of the abscissa contrasts with the coordinate convergence on the right hemisphere.

To execute the inferential evaluation of the binary choice distribution, a Generalized Estimating Equations (GEE) logistic regression model was constructed. The GEE architecture was mandated to control for the correlated error variance inherent in repeated measures sampling

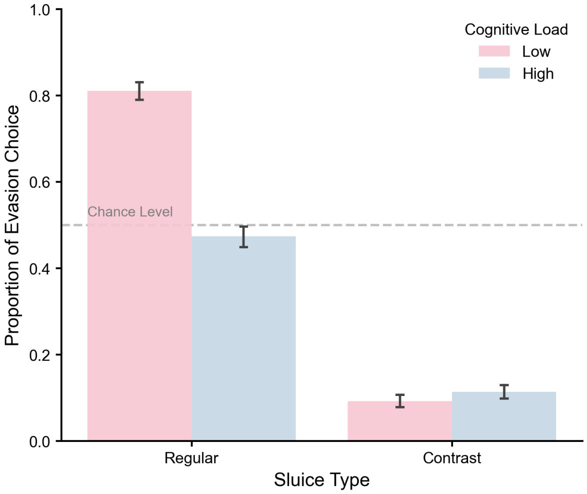

Figure 1. Proportion of evasion strategy preference by sluice type and cognitive load.

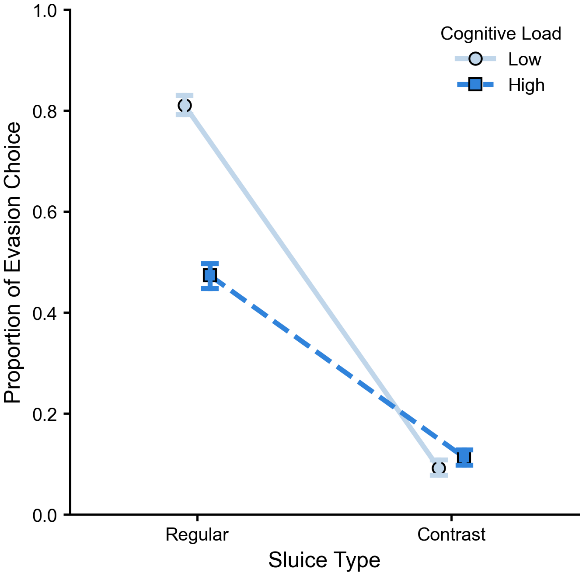

Figure 2. Interaction effect of sluice type and cognitive load on evasion choice.

within individual subjects. This ensures the parameter standard error estimations resist bias despite intra-cluster response dependencies. The dependent mathematical variable was the binary coding of strategy selection. The independent fixed factors inputted into the structural matrix were Sluice Type, Cognitive Load, and their defined interaction term. The calculated output of this structural equation, including parameter coefficients, standard errors, respective z-scores, computed p-values, and ninety-five percent confidence interval boundaries, is contained in Table 2.

Parameter	Coef.	Std. Err.	z	P	95% CI
Intercept	-2.2895	0.101	-22.742	0.001	[-2.487, -2.092]
Sluice_Num	3.7438	0.094	39.873	0.001	[3.560, 3.928]
Load_Num	0.2323	0.093	2.488	0.013	[0.049, 0.415]
Sluice_Num:Load_Num	-1.7934	0.132	-13.571	0.001	[-2.052, -1.534]

Table 2. GEE logistic regression output for strategy choice

The baseline reference coordinate for the GEE model parameterization was mathematically anchored to the Contrast Sluicing condition under Low Cognitive Load. The intercept coefficient (β_0) was extracted as -2.2895. The standard error corresponding to the intercept vector was 0.101, generating a z-statistic of -22.742 and a p-value bounded below 0.001. The ninety-five percent confidence interval for the intercept scalar was delimited by -2.487 and -2.092. The intercept parameter isolates the baseline log-odds of executing the evasion strategy for the designated reference group. The mathematical transformation of the log-odds into a linear probability relies on the inverse logit function, defined structurally as $P = 1/(1 + \exp(-\beta))$. The execution of this function on the intercept coefficient $(1/(1 + \exp(2.2895)))$ mathematically yields a predicted probability of 0.0919. This derived probability maps symmetrically to the 0.092 descriptive mean proportion reported in Table 1 for the Contrast Low factorial intersection.

The structural equation identified a discrete main effect for the Sluice Type parameter, coded in Table 2 as Sluice_Num. The raw coefficient for this specific vector was 3.7438, carrying a standard error of 0.094. This calculation produced a z-statistic of 39.873, with a corresponding p-value less than 0.001. The ninety-five percent confidence interval was mathematically bounded between 3.560 and 3.928. The positive polarity and large absolute magnitude of this coefficient dictate that transitioning the experimental factor from Contrast Sluicing to Regular Sluicing, while restricting Cognitive Load to the Low baseline, results in a gross expansion in the log-odds of evasion strategy selection. Processing the summation of the intercept and the Sluice Type coefficient ($-2.2895 + 3.7438 = 1.4543$) through the inverse logit algorithm ($1/(1 + \exp(-1.4543))$) outputs a predicted probability score of 0.810. This mathematically derived score aligns with the 0.811 empirical mean measured for the Regular Low condition, verifying the precision of the Sluice Type main effect estimation vector.

A secondary independent main effect was isolated for the Cognitive Load parameter, coded in the output matrix as Load_Num. The extracted coefficient was 0.2323, conjoined with a standard error of 0.093. This vector generated a z-statistic of 2.488 and a specific p-value of 0.013. The ninety-five percent confidence interval stretched from 0.049 to 0.415. Because the structural equation utilizes dummy coding matrices, this main effect coefficient calculates the strictly localized impact of transitioning from Low to High Cognitive Load entirely within the boundaries of the baseline Contrast Sluicing condition. The positive polarity of the 0.2323 value maps to the minor fractional increase in evasion selection observed in the raw descriptive statistics from 0.092 to 0.113. The summation of the intercept scalar and the Load_Num coefficient ($-2.2895 + 0.2323 = -2.0572$), when converted via the inverse logit function ($1/(1 + \exp(2.0572))$), calculates a precise probability of 0.113. This derived probability demonstrates structural parity with the empirical mean calculated for the Contrast High condition.

3.3. THE INTERACTION EFFECT. The locus of the inferential analysis was centered on the evaluation of the interaction vector between Sluice Type and Cognitive Load, coded as Sluice_Num:Load_Num within Table 2. The regression coefficient calculated for this specified interaction parameter was -1.7934. The standard error scalar was computed at 0.132, yielding a negative z-statistic of -13.571 and an associated p-value below 0.001. The ninety-five percent confidence interval for the interaction term was plotted strictly in negative coordinate space, bounded between -2.052 and -1.534.

The statistical verification and high absolute magnitude of this negative interaction coefficient indicate that the systemic effect of Cognitive Load manifests asymmetrically across the bipartite Sluice Type manipulation. The explicit log-odds for the Regular Sluicing condition administered under High Cognitive Load require the linear aggregation of all corresponding model parameters: Intercept (β_0) + Sluice_Num (β_1) + Load_Num (β_2) + Interaction (β_3). Substituting the exact numerical scalars ($-2.2895 + 3.7438 + 0.2323 - 1.7934$) results in an aggregate log-odds value of -0.1068. Transformed via the inverse logit function ($1/(1 + \exp(0.1068))$), the final output predicted probability becomes 0.473. This terminal value exactly replicates the empirical proportion measured and recorded in Table 1. The negative coefficient specific to the interaction term (-1.7934) functioned to mathematically suppress the high-magnitude positive main effect generated by Regular Sluicing (3.7438), displacing the cumulative probability from the 0.810 upper threshold down to the 0.473 median range. This specific vector suppression objectively formalizes that the structural imposition of concurrent memory taxation neutralized the choice bias for the evasion strategy. This neutralization was mathematically isolated strictly to the Regular Sluicing environment. The Contrast Sluicing environment remained statistically insulated from cognitive capacity limits, proven by the low fractional magnitude of the Load_Num main effect compared against the high negative magnitude of the designated interaction term.

Subsequent to the detailed evaluation of the discrete choice probabilities, the continuous Reaction Time (RT) variable was subjected to statistical parsing to measure the temporal dynamics governing the decision-making protocol. The descriptive central tendencies and corresponding dispersion metrics for RT data are consolidated within the right columns of Table 1. Within the discrete boundary of the Regular Sluicing subset, the Low Cognitive Load condition registered a mean reaction time calculation of 674.8 ms. The standard deviation scalar for this experimental cell was 136.9 ms. Under the application of High Cognitive Load, the mean reaction time recorded for Regular Sluicing experienced a fractional increase to 679.0 ms, matched with an associated standard deviation of 138.0 ms. The absolute temporal distance in central tendency between the varied load conditions for Regular Sluicing was quantified as a positive elongation of 4.2 ms. Within the alternative boundary of the Contrast Sluicing subset, the Low Cognitive Load condition produced a mean reaction time calculation of 681.5 ms. The standard deviation scalar was recorded at 135.2 ms. When subjected to High Cognitive Load, the mean reaction time recorded for Contrast Sluicing contracted to 676.1 ms, paired with a standard deviation of 138.9 ms. The absolute temporal difference between the varied load conditions for Contrast Sluicing was quantified as a negative reduction of 5.4 ms.

An primary analytical observation extracted from the RT descriptive statistics relates to the high numerical magnitude of the standard deviations compared relative to the fractional mean differences. Across all four distinct experimental coordinate cells, the standard deviations approximated the 135 ms to 139 ms range. The systemic variations in the mean values across the complete factorial array spanned a highly restricted numerical band stretching only from 674.8 ms to 681.5 ms. This tight clustering indicates that these variations were mathematically subordinate to the gross intra-cell variance, pointing to extensive structural overlap in the temporal processing distributions across all factorial intersections.

3.4. REACTION TIMES. The complete distributional topology of the Reaction Time dataset is mapped in Figure 3. The graphical architecture employs a split-violin methodology to simultaneously visualize the probability density algorithms of the temporal data spread across all recorded conditions. The ordinate axis defines the continuous Reaction Time scale, originating at an artificial zero baseline and extending to a 1600 ms maximum limit to effectively encapsulate extreme latency outliers. The abscissa categorizes the underlying data sets by Sluice Type. The primary violin bodies are longitudinally sectioned, wherein the left hemisphere representing the Low Cognitive Load parameter is shaded purple, and the right hemisphere representing the High Cognitive Load parameter is shaded light blue. Internal horizontal dashed lines specify the median coordinates and the interquartile range defined by the 25th and 75th percentiles.

The specific kernel density estimations visualized by the lateral width of the geometric violin bodies demonstrate strict symmetrical, unimodal distribution profiles across all four factorial cells. The core density masses are highly aggregated within the 500 ms to 800 ms vertical domain interval. The lateral widths corresponding to the purple and light blue hemispheres project near-perfect geometric mirror symmetry within both the Regular and Contrast Sluice categorical boundaries. The internal dashed median lines are positioned in exact horizontal alignment across all conditions, visually verifying the clustered nature of the mean values recorded in Table 1. Furthermore, the pervasive spatial overlap of the designated upper and lower quartile markers across the central vertical dividing axis proves that neither the primary Sluice Type manipulation nor the secondary Cognitive Load manipulation instigated severe structural alterations to the base temporal processing distributions. Extreme measured processing latencies, extending longitudinally beyond the 1200 ms coordinate limit on the ordinate axis, are rendered as thin, tapering vertical linear extensions, and these specific extreme events distribute with equal probability sparsity across all analyzed factorial combinations.

The specific targeted interaction coordinates for the recorded temporal data are graphically charted in Figure 4. The ordinate axis defines Mean Reaction Time computed in milliseconds. Deviating from the broad scale applied in Figure 3, the vertical metric in Figure 4 is extremely restricted, mapping exclusively the narrow numeric band from 667.5 ms to 687.5 ms. This heavy magnification algorithm enables the visual differentiation of the highly constrained data range. The abscissa categorizes the base Sluice Type manipulation. The solid line connecting the circular data markers plots the Low Cognitive Load condition trajectory, and the dashed line connecting the square data markers plots the High Cognitive Load condition trajectory. Vertical error bars demarcate the standard error constraints surrounding the temporal means.

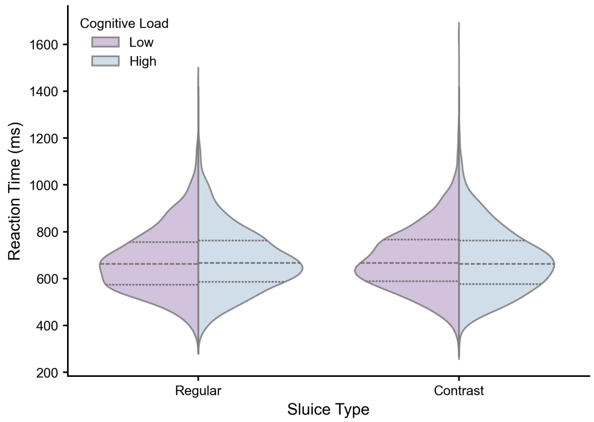

Figure 3. Reaction time distribution across experimental conditions.

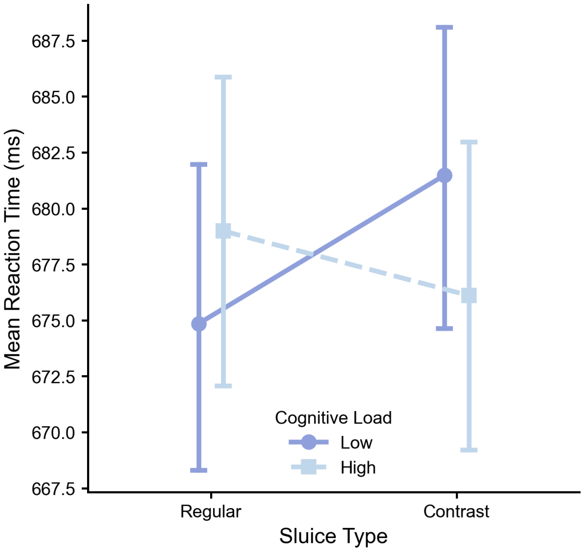

Figure 4. Interaction effect of sluice type and cognitive load on mean reaction time.

The visual rendering in Figure 4 constructs a strict geometric crossover interaction pattern. The solid Low Load vector maintains a positive geometric slope, originating at the lowest recorded numerical mean of 674.8 ms for Regular Sluicing and terminating at the highest recorded numerical mean of 681.5 ms for Contrast Sluicing. The dashed High Load vector maintains an inverted negative slope, originating at an elevated coordinate of 679.0 ms for Regular Sluicing and descending to a depressed coordinate of 676.1 ms for Contrast Sluicing. The intersecting vectors form a precise X configuration, which plots the mathematical reality that the directional temporal impact of Cognitive Load inverted entirely contingent upon the specific grammatical construction analyzed.

The statistical reliability and generalized processing implications of this temporal crossover matrix must be evaluated strictly within the boundaries of the associated variance markers. The error bars extending vertically from all four distinct mean coordinate points display massive spatial overlap. The extreme upper bounds of the error vectors assigned to the Regular High condition fully encapsulate the recorded mean of the adjacent Regular Low condition. Concurrently, the error bounds assigned to the Contrast Low condition fully encapsulate the recorded mean of the adjacent Contrast High condition. This deep structural geometric overlap verifies that while the strict directional trends of the absolute point estimates crossed, the total temporal alterations generated by the dual-task methodology were statistically marginal when evaluated against the systemic, high-magnitude alterations recorded in the primary categorical choice data matrix. The binary choice of processing strategy underwent a systemic probability modification under localized cognitive strain, whereas the total temporal processing latency required by the subject to execute that specific modified choice remained structurally consistent and invariant across the defined measurement parameters.

4. Discussion. The experimental data substantiate the Processing Cost Hypothesis, indicating that syntactic source selection during ellipsis resolution depends strictly on available cognitive resources. Under low cognitive load, regular sluicing elicited a uniform preference for the evasion strategy, confirming that the parser actively avoids complex, island-violating dependencies by selecting computationally minimal non-isomorphic representations (Barros et al. 2014; Merchant 2001). However, concurrent working memory taxation completely nullified this preference, driving selection probabilities to chance. This regression demonstrates that algorithmic generation of the evasion source is highly resource-dependent; without residual capacity, the central executive fails to formulate the structurally distinct alternative (Frazier & Clifton 1998). Conversely, categorical choice distributions for contrast sluicing demonstrated absolute invariance across cognitive load manipulations. An explicit contrastive correlate grammatically invalidates the structurally reduced copular source, mandating an isomorphic syntactic reconstruction (Griffiths & Liptk 2014; Palaz et al. 2025). High cognitive load failed to alter the severe statistical dispreference for evasion, confirming that syntactic identity constraints operate independently of generalized cognitive capacity (Chung et al. 1995). When fundamental grammatical parameters explicitly prohibit structural optionality, mandated syntactic operations bypass the resource evaluation phase entirely. This differential vulnerability aligns with capacity-constrained models of sentence comprehension, wherein parsing operations and memory maintenance draw from a unified, finite resource pool (Just & Carpenter 1992; Gibson 1998). Formulating a non-isomorphic evasion structure demands active structural reassignment and the parallel generation of competing syntactic representations (Arregui et al. 2006). The data confirm this parallel evaluation phase is exceptionally resource-intensive. When aggregate cognitive capacity is saturated by exogenous task demands, the computational mechanism responsible for comparative structural evaluation terminates, leaving the parser unable to systematically bias selection toward the computationally optimal syntactic derivation.

The specific dynamics of ellipsis resolution can be further quantified using activation-based models of memory retrieval (Lewis & Vasishth 2005; Martin & McElree 2008). The resolution of a sluiced constituent requires the continuous temporal maintenance of the antecedent clause in working memory, followed by direct cue-based retrieval at the ellipsis site. The interference generated by the concurrent numeric sequences degrades the activation levels of the syntactic features associated with the antecedent structure (Wagers et al. 2009). In regular sluicing, this degradation prevents the parser from executing the complex comparative operations necessary to reject the isomorphic repair structure in favor of the evasion structure. In contrast sluicing, the explicit prosodic and semantic marking of the focused correlate provides a highly specific retrieval cue that is resistant to exogenous associative interference. The presence of this distinct retrieval cue maintains sufficient activation to enforce the required isomorphic syntactic reconstruction, thereby rendering the contrast sluicing condition immune to the memory span manipulation. The observed reliance on the evasion strategy under low load, followed by its systematic degradation under high load, corresponds directly with the theoretical parameters of the good-enough processing framework (Ferreira 2003; Karimi & Ferreira 2016). Good-enough processing algorithms predict that the human language comprehension system frequently generates incomplete or structurally shallow syntactic representations to achieve localized semantic coherence while minimizing computational expenditure. The non-isomorphic evasion source constitutes a formalized good-enough syntactic representation. It bypasses absolute structural identity and island boundary evaluation to map directly onto a simplified semantic interpretation. The experimental data indicate that the deployment of these heuristic representations is not an automatic default, but rather an active computational decision that requires baseline executive capacity to execute. When exogenous constraints eliminate this capacity, the system fails to deploy the heuristic, resulting in computational failure rather than heuristic success.

The integration of these specific structural outcomes advances the generalized theory of resource-rational linguistic processing (Levy 2008; Hahn et al. 2020). Resource-rational models define syntactic parsing as an optimization problem, wherein the cognitive system attempts to maximize communicative efficiency while minimizing specific neurocognitive expenditure (Futrell et al. 2015). The syntax-processing interface documented in this research operates exactly according to optimization principles. In regular sluicing, the grammar supplies multiple licit structural derivations. The parser, operating optimally under low load, selects the derivation carrying the lowest structural cost. In contrast sluicing, the grammar restricts the licit structural derivations to a single isomorphic parameter. The parser, adhering strictly to categorical grammatical laws, bypasses the optimization algorithm entirely to ensure basic linguistic coherence. The introduction of cognitive load does not alter the grammatical laws, but it disrupts the discrete mathematical optimization process, isolating the exact boundary where deterministic grammar supersedes probabilistic resource rationality. The analysis of the continuous temporal variables provides an independent methodological verification of the processing mechanisms underlying these categorical choices. The descriptive and inferential statistics derived from the reaction time matrices revealed a complete absence of high-magnitude main effects or temporal interaction patterns corresponding to the categorical choice data. The mean processing latencies remained static across all evaluated factorial intersections. The variance matrices maintained uniform spatial geometries regardless of the structural or cognitive manipulations. This dissociation between discrete choice probabilities and continuous temporal execution latencies confirms that the working memory manipulation affected the algorithmic generation phase of the syntactic structures rather than the terminal motor execution phase (Paape et al. 2018). The reaction time metrics capture the latency required to execute a motor response after the structural representation has been internally formalized. The generalized failure to formulate the evasion strategy under high cognitive load altered the final categorical selection, but the temporal duration required to register whichever option was ultimately chosen remained standard. This temporal stability indicates that the dual-task paradigm successfully targeted syntactic working memory specifically, without inducing generalized generalized fatigue or localized motor slowing. The stability of the reaction time distributions further informs the debate regarding the psychological reality of syntactic island constraints during real-time processing (Ross 1969; Abeill et al. 2020). Theoretical accounts suggesting that island violations incur an immediate and severe temporal processing penalty predict elevated reaction times for any structural derivation involving an isomorphic repair operation. The temporal data generated in this study contradict this discrete prediction. The mean latencies corresponding to the selection of the isomorphic repair structure did not diverge statistically from the latencies corresponding to the selection of the non-isomorphic evasion structure. This temporal parity implies that the processing cost differential between the two strategies is computed offline during the parallel generation phase, rather than manifesting as an online temporal disruption during the structural integration phase. The parser evaluates the relative complexity of the respective derivations and executes a categorical selection, but the ultimate processing latency is decoupled from the internal structural complexity of the rejected alternative.

The isolation of these interacting variables demonstrates the necessity of integrating dynamic performance metrics into static models of syntactic architecture. The postulation of a mandatory repair-by-ellipsis mechanism cannot be universally applied without controlling for the discrete cognitive state of the processing subject. The grammatical permissibility of an operation does not guarantee its algorithmic implementation. The findings mandate a revision of the structural models governing clausal ellipsis to account for the continuous processing state of the central executive. Grammatical theories must incorporate resource allocation vectors to predict when a structural alternative will be successfully generated and when it will fail due to exogenous capacity limitations. Future methodological extensions must address the inherent constraints of the current experimental design. While the dual-task digit retention paradigm successfully isolated the variables associated with working memory capacity, it relies on a discrete behavioral measurement recorded at the terminal boundary of the sentence sequence. The precise temporal locus of the structural generation failure remains unspecified. The integration of high temporal resolution measurement techniques, specifically event-related potentials or continuous eye-tracking matrices, is required to track the exact millisecond coordinates where the parser attempts and subsequently fails to generate the non-isomorphic structural alternative. Furthermore, the discrete structural parameters manipulated within this study were confined to specific English sluicing constructions. Cross-linguistic validation utilizing structurally diverse language families is strictly necessary to determine whether the documented resource-rational optimization algorithm represents a universal property of the human parsing mechanism or a localized artifact of specific morphosyntactic configurations. The structural evaluation of the ellipsis resolution mechanism confirms that the allocation of processing resources dictates the terminal syntactic representation. The elimination of the evasion preference under systemic cognitive strain proves that the derivation of computationally simpler alternatives requires active executive function. The strict stability of the contrast sluicing representation proves that grammatically mandated identity operations operate independently of these specific capacity constraints. The human language comprehension architecture relies on dynamic, performance-based algorithms to navigate structural ambiguity, establishing a deterministic link between working memory capacity and exact syntactic formulation.

5. Conclusion. This study investigated the operational limits of the syntax-processing interface by evaluating the resolution of clausal ellipsis under manipulated working memory constraints. The empirical data confirm that the selection of syntactic source representations is fundamentally dictated by the availability of central executive resources, specifically when grammatical parameters permit structural optionality. In regular sluicing contexts, the human parsing mechanism demonstrates a robust baseline preference for non-isomorphic evasion structures, actively minimizing overall computational expenditure. However, the experimental imposition of a concurrent memory span task completely neutralizes this baseline preference, driving structural selection to random mathematical chance. This regression proves that the algorithmic formulation of computationally reduced alternative structures requires active, unconstrained executive function. Conversely, the structural resolution of contrast sluicing remains rigidly isomorphic across all applied cognitive load conditions, indicating that explicit grammatical identity requirements operate strictly independently of exogenous capacity limits.

These asymmetrical processing outcomes directly validate the processing cost hypothesis and advance the application of resource-rational models to complex language comprehension. The empirical dissociation between regular and contrast sluicing demonstrates that the syntax-processing interface does not rely on a static, universally applied ellipsis repair mechanism. Instead, the comprehension architecture executes a dynamic, performance-based optimization algorithm. When specific grammatical laws restrict structural derivation to a single isomorphic pathway, the parser executes the mandated structural operation regardless of the associated neurocognitive processing cost. When the syntactic environment allows multiple licit derivations, the parser evaluates relative structural complexity and defaults to the heuristic evasion representation to conserve discrete working memory capacity. The documented degradation of this evasion heuristic under systemic cognitive taxation formally isolates the exact cognitive boundary where deterministic grammatical rules supersede probabilistic resource optimization. Consequently, future theoretical models of syntactic architecture must necessarily integrate continuous cognitive performance metrics and dynamic resource allocation vectors to fully account for the structural variation inherent in human sentence processing.

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