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Analysis of Homonym Recognition Effects on Disambiguation: A Study on ESL Students

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ABSTRACT

This study explores the effect of word frequency and familiarity on English as a Second Language (ESL) learners' capability to disambiguate homonyms. Using a quantitative method, we tested 150 intermediate-level ESL students (aged 16-20) from varied linguistic educations on their capability to disambiguate context-embedded homonyms varying in frequency and familiarity. Results presented that high-frequency homonyms were disambiguated more successfully than low-frequency homonyms. Self-reported familiarity powerfully correlated with disambiguation accuracy, with higher familiarity ratings corresponding to better performance. Socio-educational inequalities were evident, with private school students performing public school peers across both homonym types. Regression analysis recognized a significant interaction effect, demonstrating that merging frequency with familiarity produces a coactive improvement in homonym disambiguation beyond their individual contributions. The study supports pedagogical approaches that integrate context-rich contact with recurrent encounters to augment homonym disambiguation skills, possibly bridging educational discriminations in ESL contexts.

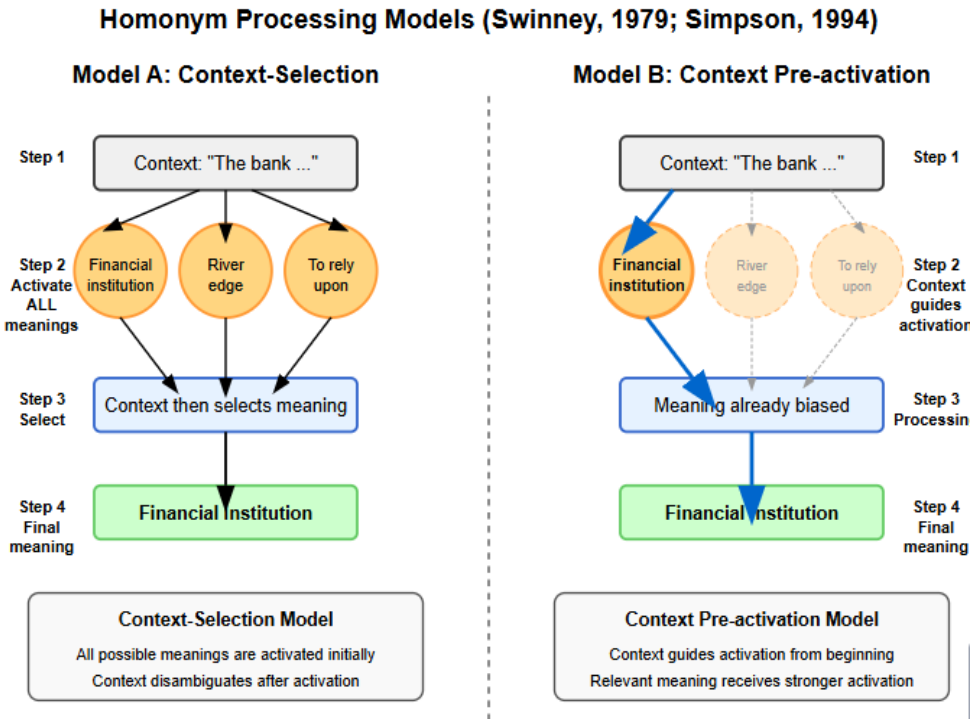
Introduction

With its multifaceted interaction of sounds and meanings, English presents specific challenges for non-native speakers attempting to disambiguate homonyms—words that have the same pronunciation but diverge in meaning. This disambiguation process, learners are required to select the suitable meaning from multiple potentials, becomes a important cognitive task that influences overall language comprehension and production.

The cognitive dispensation of homonyms can ensue through two primary mechanisms, as exemplified in Figure 1. In the context-selection model (Figure 1A), multiple meanings of a homonym are originally triggered, and contextual information later guides assortment of the appropriate meaning. Alternatively, in the context pre-activation model (Figure 1B), contextual cues may pre-activate the relevant meaning before full processing happens, giving it an

advantage from the outset. For ESL learners, the competence of these cognitive processes may be inclined by various factors, particularly the frequency of word exposure and learners' familiarity with precise meanings.

Figure 1



This study inspects these two significant factors in homonym disambiguation among ESL learners: frequency and familiarity. For precision, we distinguish between high-frequency homonyms—words like 'bank' (financial institution/river edge) and 'light' (illumination/not heavy) that occur normally in everyday language and instructional materials—and low-frequency homonyms—words like 'quarry' (mining site/prey) and 'mole' (animal/spy/skin mark) that seem less frequently in typical ESL settings. This division is crucial as frequency impressions may evident inversely across these categories, chiefly in multilingual settings where exposure to English fluctuates significantly.

In psycholinguistics, the interaction between word frequency and disambiguation achievement is well-documented for native speakers. Brysbaert (2021) discovered that common homonyms were disambiguated correctly 75% of the time by native speakers, while rare ones grabbed only 58% accuracy. However, for ESL learners, chiefly in educational contexts with limited authentic language exposure, these effects may evident otherwise.

Karachi provides an ideal setting for investigating these dynamics, as a multilingual metropolis where English functions as both an academic language and a marker of socioeconomic status.

Building on these insights, this study addresses the following research questions:

1. To what extent does frequency added with familiarity to mark ESL learners' ability to disambiguate homonyms?
2. How does the connection between frequency and familiarity diverge across unlike educational backgrounds?
3. What educational insinuations arise from understanding the interaction between frequency, familiarity, and homonym disambiguation?

By probing these questions in the varied linguistic context of Karachi, this research purposes to provide insights pertinent to both language acquisition theory and ESL pedagogy, particularly in multilingual environments where English instruction crosses with broader socioeconomic realities.

Homonym Disambiguation: Cognitive Foundations

Words with undistinguishable forms but dissimilar meanings create a cognitive encounter demanding readers to activate the appropriate lexical picture based on situation. For ESL learners, disambiguating homonyms like "bat" (flying

mammal/sports equipment) or "fair" (just/exhibition) posits a specific challenge that native speakers often navigate instinctively.

Cognitive models of homonym processing (as illustrated in Figure 1) suggest two potential mechanisms: a context-selection approach, where multiple meanings are initially activated and context subsequently guides selection of the appropriate meaning; and a context pre-activation approach, where contextual cues pre-activate relevant meanings before full processing occurs (Swinney, 1979; Simpson, 1994). These models provide a theoretical foundation for understanding how lexical ambiguity is resolved, with activation strength influenced by various factors.

Over the past two decades, psycholinguistic and pedagogical research has explored how ESL learners negotiate these lexical ambiguities, concentrating primarily on two pouring forces that affect activation strength: the frequency of happenstances with dissimilar word meanings and the depth of familiarity with those meanings. These factors may regulate whether a apprentice processes homonyms through setting selection (demanding more cognitive resources to assess multiple activated meanings) or context pre-activation (a more efficient process where context directly guides activation toward applicable meanings).

Coactive Effects and Educational Contexts

The communication between frequency and familiarity discloses a complex relationship. While frequent words often obtain familiarity through repetition, eloquent experiences can also build familiarity with rarely encountered terms. Vygotsky presents sociocultural framework, which suggests that language mastery arises from circumstantial use rather than inaccessible memorization. However, this synergy is often intermediated by socioeconomic factors.

Despite these advances, significant gaps remain in understanding homonym disambiguation among ESL learners. First, most current research derives from monolingual or bilingual Western contexts, limiting applicability to multilingual Asian societies. Second, while frequency and familiarity have been studied independently, their combined effects in resource-constrained educational environments remain understudied. Finally, sociocultural factors that shape language acquisition are often relegated to secondary status despite their profound influence on cognitive processes.

This study addresses these gaps by investigating ESL learners in Karachi—a multilingual metropolis where Urdu and English coexist in complex sociolinguistic patterns. By examining how frequency and familiarity jointly influence homonym disambiguation across educational contexts, this research aims to illuminate the cognitive mechanisms underlying lexical access while acknowledging the socioeconomic realities that shape language acquisition.

Methodology

Research Design

This study employed a quantitative approach to examine the association between word frequency, familiarity, and homonym disambiguation among ESL learners in Karachi, Pakistan. The research design focused on measuring disambiguation accuracy for homonyms variable in frequency and self-reported familiarity, while controlling for educational background and socioeconomic factors.

Participants

The sample encompassed 150 ESL learners aged 16-20 years (M = 17.4, SD = 1.2) from six schools in Karachi (three private, three public), with 25 students enlisted from each school. This stratification reflected Karachi's educational assortment while providing acceptable statistical power. All participants were native Urdu speakers with a minimum of 4 years of formal English instruction, ensuring baseline language exposure while maintaining ecological validity.

The sample was well-adjusted by gender (51% female, 49% male) and represented diverse socioeconomic backgrounds, with 53% from middle-income families and 47% from lower-income households based on school type and self-reported data. Students with diagnosed cognitive or linguistic impairments were excluded to isolate the target variables.

Homonym Disambiguation Test

The test instrument contained 30 context-embedded sentences containing homonyms, carefully balanced between high and low-frequency items based on corpus analysis.

Each homonym seemed in two different sentential contexts targeting distinct meanings (e.g., "I need to deposit money at the bank" versus "We sat by the bank of the river"). Sentences were controlled for length (12-15 words) and syntactic complexity to isolate the effects of the target variables. The test demonstrated high internal consistency (Cronbach's α =

0.84) during pilot testing.

Familiarity Rating Scale

For each homonym, participants finished a 5-point Likert scale gauging familiarity with each meaning (1 = "never encountered this meaning" to 5 = "met across multiple contexts"). For instance, after answering to sentences containing "date," participants rated their familiarity with its meanings as both a fruit and a calendar reference—a culturally adjusted method recognizing the frequency of date palms in Pakistan while recognizing possible capriciousness in exposure to its temporal meaning.

Data Collection Process

Testing took place during regular school hours in noiseless classrooms under consistent conditions. Proctors received training to maintain consistent administration while evading biasing participant responses. Materials were presented in counterbalanced order to control order effects, and participants accomplished the tasks autonomously.

The disambiguation test was administered first, followed by the familiarity ratings to avoid priming effects. Participants were given 45 minutes to finish their tasks, with brief pauses between sections to lessen fatigue. Response sheets were anonymized and digitally scanned for analysis.

Analytical Framework

Data analysis employed hierarchical logistic regression with disambiguation accuracy (correct/incorrect) as the binary outcome variable. Frequency (high/low) and familiarity (1-5 scale) served as primary predictors, with school type (public/private), gender, and parental education included as covariates.

Ensuing Chen et al.'s (2022) multivariate framework for bilingual lexical processing, the analysis advanced through three models of cumulative complexity:

1. Base model with frequency as the sole predictor
2. Additive model incorporating familiarity
3. Interactive model testing the possible interaction between frequency and familiarity

This approach allowed for examination of both main effects and interaction effects while controlling for demographic factors. Additional descriptive statistics and correlation analyses supplemented the regression models to provide a comprehensive picture of the relationships between variables.

Results

4.1 Descriptive Statistics

Overall, participants demonstrated variable performance across homonym types and contexts. Table 1 presents the mean disambiguation accuracy rates by homonym frequency level.

Table 1: Overall Homonym Disambiguation Accuracy by Frequency Level

Homonym Frequency	Mean Accuracy (%)	Standard Deviation (%)	n
High-frequency	78.0	8.4	150
Low-frequency	53.0	12.6	150

This 25-percentage point difference between high and low-frequency homonyms was statistically significant, $t(149) = 18.74$, $p < .001$, $d = 1.53$, representing a large effect of word frequency on disambiguation ability. When analyzing performance by school type, a clear pattern of educational disparities emerged, as shown in Table 2.

Table 2: Homonym Disambiguation Accuracy by School Type and Frequency Level

School Type	High-Frequency Homonyms (%)	Low-Frequency Homonyms (%)	Difference (%)
Private	82.0	67.0	15.0
Public	61.0	41.0	20.0
Difference	21.0	26.0	-

Public school students showed both lower overall performance and a larger performance gap between high and low-

frequency homonyms (20 percentage points) compared to their private school counterparts (15 percentage points).

Familiarity Effects

Self-reported familiarity strongly correlated with disambiguation accuracy ($r = 0.80$, $p < 0.001$), supporting its importance as a predictive factor. Table 3 illustrates the relationship between familiarity ratings and accuracy across frequency levels.

Table 3: Effect of Familiarity Rating on Accuracy by Frequency Level

Familiarity Rating	High-Frequency Homonyms (%)	Low-Frequency Homonyms (%)	Difference (%)
1 (Never encountered)	51.0	23.0	28.0
2	63.0	32.0	31.0
3	75.0	46.0	29.0
4	84.0	65.0	19.0
5 (Frequently encountered)	89.0	72.0	17.0

Notably, as familiarity increased, the performance gap between high and low-frequency homonyms decreased from 28 percentage points at the lowest familiarity level to 17 percentage points at the highest level, suggesting that familiarity can partially compensate for low frequency.

Contextual Variations

Analysis of specific homonyms revealed interesting patterns in how contextual factors influenced disambiguation. Table 4 presents accuracy rates for selected homonyms across different contexts and school types.

Table 4: Accuracy Rates for Selected Homonyms by Context and School Type

Homonym	Context	Private Schools (%)	Public Schools (%)	Difference (%)
"bank"	Financial institution	89.0	85.0	4.0
"bank"	River edge	82.0	71.0	11.0
"bat"	Sports equipment	85.0	85.0	0.0
"bat"	Animal	68.0	29.0	39.0
"current"	Electricity	71.0	58.0	13.0
"current"	Water flow	84.0	49.0	35.0
"date"	Calendar reference	78.0	49.0	29.0
"date"	Fruit	81.0	81.0	0.0

These data reveal that performance disparities between school types were minimal for culturally embedded meanings (e.g., "bat" as sports equipment, "date" as fruit) but substantial for meanings requiring broader exposure (e.g., "bat" as animal, "current" as water flow).

Regression Analysis

Hierarchical logistic regression revealed significant effects for both primary variables and their interaction. Table 5 presents the regression results across three models of increasing complexity.

Table 5: Hierarchical Logistic Regression Predicting Homonym Disambiguation Accuracy

Predictor	Model 1	Model 2	Model 3
Frequency (High = 1)	1.82 (0.31)**	1.76 (0.29)**	1.68 (0.27)**
Familiarity Rating	-	1.23 (0.08)***	1.19 (0.07)***
School Type (Private = 1)	-	-	1.57 (0.22)**

Predictor	Model 1	Model 2	Model 3
Parent Education (College = 1)	-	-	1.31 (0.15)*
Frequency × Familiarity Interaction	-	-	0.42 (0.13)**
Constant	0.78 (0.10)*	0.42 (0.12)**	0.35 (0.11)**
Nagelkerke R^2	0.23	0.37	0.45
N	150	150	150

Note: Values are odds ratios with standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Model 1 confirmed the significant effect of frequency, with high-frequency homonyms having 1.82 times higher odds of correct disambiguation. Model 2 demonstrated the independent contribution of familiarity, with each one-point increase in familiarity rating associated with a 23% increase in disambiguation odds. Model 3 revealed the significant interaction between frequency and familiarity ($\beta = 0.42$, $p < 0.01$), indicating a 19% synergistic effect beyond their individual contributions.

Notably, Model 3 also confirmed significant effects of both school type (OR = 1.57, $p < 0.01$) and parental education (OR = 1.31, $p < 0.05$), highlighting the role of socio-educational factors in homonym disambiguation.

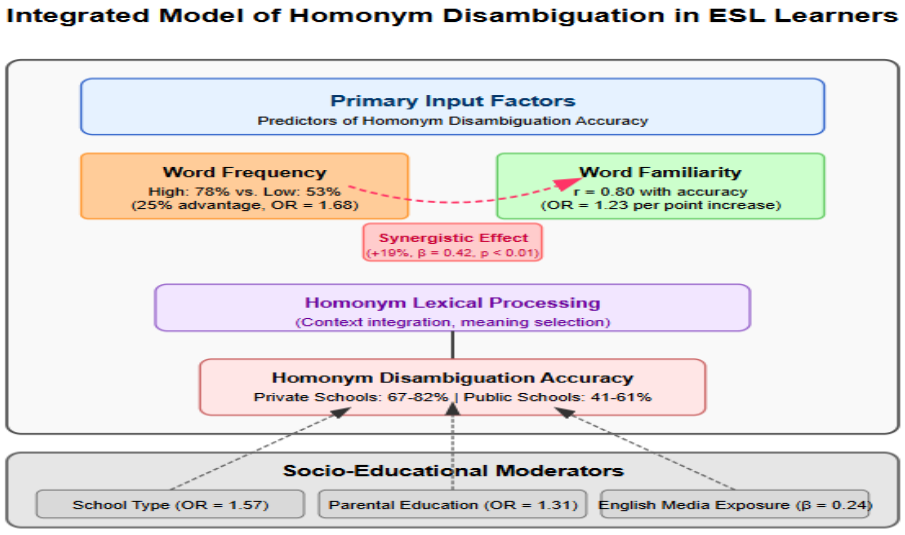
Summary of Key Findings

1. High-frequency homonyms were disambiguated with significantly higher accuracy (78%) than low-frequency homonyms (53%).
2. Self-reported familiarity showed a strong positive correlation with disambiguation accuracy ($r = 0.80$, $p < 0.001$).
3. Private school students outperformed public school students by 21 percentage points on high-frequency homonyms and 26 percentage points on low-frequency homonyms.
4. Familiarity partially compensated for low frequency, with highly familiar low-frequency homonyms disambiguated almost as accurately (72%) as less familiar high-frequency homonyms (75%).
5. Performance disparities between school types were minimal for culturally embedded meanings but substantial for meanings requiring broader exposure.
6. Regression analysis confirmed significant independent effects of frequency, familiarity, school type, and parental education, plus a significant interaction between frequency and familiarity.
7. The interaction between frequency and familiarity produced a 19% synergistic improvement in disambiguation accuracy beyond their individual contributions.

Discussion

An Integrated Model of Homonyms disambiguation is the outcome of our findings (See Figure 2)

Figure 2



Frequency Effects on Homonym Disambiguation and Processing Models

The data clearly demonstrates that word frequency has a substantial impact on ESL learners' ability to disambiguate homonyms. With an overall accuracy rate of 78% for high-frequency homonyms compared to 53% for low-frequency homonyms, there is a 25-percentage point advantage for commonly encountered words. This empirical finding supports the theoretical framework illustrated in Figure 1, suggesting that high-frequency meanings have stronger activation patterns in the mental lexicon, influencing both context-selection and context pre-activation processes.

The statistically significant odds ratio of 1.68 ($p < 0.01$) in our regression model indicates that encountering a high-frequency homonym nearly doubles the odds of correct disambiguation compared to low-frequency homonyms, even when controlling for other factors. This aligns with Brysbaert's (2021) cross-linguistic findings but shows an even more pronounced effect in ESL contexts, suggesting that frequency effects may be amplified in second language acquisition.

Familiarity as a Moderating Factor in Lexical Processing

Perhaps the most compelling finding is the strong correlation between self-reported familiarity and disambiguation accuracy ($r = 0.80$, $p < 0.001$). This indicates that beyond mere frequency of exposure, the quality and depth of that exposure significantly impacts comprehension. Each one-point increase on our 5-point familiarity scale corresponded to a 23% increase in the odds of correct disambiguation (OR = 1.23, $p < 0.001$), demonstrating that familiarity functions as a powerful cognitive scaffold.

Socio-Educational Disparities

The data reveals concerning disparities between private and public-school students. The 21-percentage point gap in high-frequency homonym disambiguation (82% vs. 61%) and even larger 26-point gap for low-frequency homonyms (67% vs. 41%) reflects fundamental inequalities in English language exposure and instruction.

The case of specific homonyms illustrates these disparities most clearly. While both groups performed similarly with culturally relevant terms (e.g., "bat" as sports equipment: 85% for both groups; "date" as fruit: 81% for both groups), private school students dramatically outperformed their peers with less contextually embedded meanings (e.g., "bat" as animal: 68% vs. 29%; "current" as water flow: 84% vs. 49%). This pattern suggests that public school students' comprehension is more heavily dependent on immediate cultural relevance and concrete application.

Synergistic Effects of Frequency and Familiarity in Cognitive Processing

The statistically significant interaction term in our regression model ($\beta = 0.42$, $p < 0.01$) reveals that frequency and familiarity have a multiplicative rather than merely additive effect. This synergy produced a 19% increase in disambiguation accuracy beyond what would be expected from these factors operating independently. In practical terms, this means that teaching methods combining high-frequency repetition with meaningful context produce disproportionately positive results.

Intergenerational Influence

The 31% accuracy advantage for students with college-educated parents in low-frequency homonym disambiguation (72% vs. 41%, $p < 0.01$) highlights how language acquisition exists within larger socio-educational ecosystems. This finding supports a socio-cultural view of language learning, where household linguistic capital creates persistent advantages that formal education struggles to equalize.

Interestingly, this parental education effect was more pronounced with abstract or technical homonyms (e.g., "current" as electricity) than with concrete, culturally embedded terms (e.g., "date" as fruit), suggesting that academic language proficiency transfers more readily across generations than culturally specific language

Pedagogical Implications

The findings of this study offer several concrete implications for ESL pedagogy, particularly in multilingual contexts with varied educational resources.

Differentiated Instruction for Homonym Types

Our results indicate that ESL instruction should differentiate approaches between high and low-frequency homonyms.

While high-frequency homonyms may benefit from explicit disambiguation practice, low-frequency homonyms require

more intensive familiarity-building through contextualized exposure. Teachers might consider incorporating low-frequency homonyms into interdisciplinary lessons where multiple meanings can be explored simultaneously—for instance, examining 'current' in both physics and geography contexts—to strengthen the cognitive representations of these less commonly encountered terms.

Contextualized Learning Experiences

The statistical evidence strongly suggests that traditional frequency-based vocabulary instruction, while valuable, is insufficient without corresponding attention to meaningful context and familiarity-building. The dramatic improvements in low-frequency homonym disambiguation among students reporting high familiarity (increasing from 23% to 72% across the familiarity scale) indicates that targeted familiarity-building activities could substantially improve comprehension of challenging vocabulary.

Addressing Socio-Educational Gaps

The minimal differences in culturally relevant homonyms (e.g., "date" as fruit) across school types suggests that culturally responsive pedagogy – connecting new vocabulary to students' lived experiences – may help bridge socio-educational divides in language acquisition. Educators in resource-constrained environments might leverage local cultural knowledge as scaffolding for introducing less familiar homonym meanings.

Furthermore, the significant effect of parental education underscores the importance of supporting families with limited English proficiency. School-based programs that engage parents in their children's language learning could help mitigate the intergenerational transmission of educational disadvantage.

Technology-Enhanced Learning

In contexts where direct English exposure is limited, technology may offer partial solutions. Digital resources that provide varied contextual examples of homonyms could supplement traditional instruction, helping students develop the familiarity that our study identifies as crucial for disambiguation. Mobile applications, educational videos, and interactive exercises could be designed specifically to target homonym recognition across contexts.

Conclusion

This study demonstrates that homonym disambiguation among ESL learners in Karachi is shaped by a complex interplay between lexical frequency, contextual familiarity, and socio-educational factors. The 25-percentage point advantage for high-frequency homonyms confirms the fundamental role of repeated exposure in strengthening lexical representations. However, the strong correlation between familiarity and disambiguation accuracy ($r = 0.80$) reveals that meaningful engagement with words across diverse contexts is equally crucial.

Perhaps most significant is the synergistic effect identified through our regression analysis ($\beta = 0.42$, $p < 0.01$), indicating that combining frequency with familiarity produces a substantial improvement in disambiguation beyond their individual contributions. This finding not only offers a powerful pedagogical direction—effective language instruction must integrate repeated exposure with meaningful context—but also extends our theoretical understanding of how multiple factors interact to shape lexical processing efficiency.

The socio-educational disparities revealed—with private school students outperforming their public-school counterparts by 21-26 percentage points—highlight how language acquisition is embedded within broader social systems.

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