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Mazes Production in Typical Monolingual and Bilingual Children

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Abstract

Mazes offers a valuable window into how children plan and monitor their speech in real time, particularly during cognitively demanding activities such as narration. Although such disfluencies are a typical part of development, their distribution and patterns can provide important insights into underlying language processing mechanisms. In bilingual settings, where children navigate two linguistic systems together, these patterns may show meaningful variation. Despite this, normative data for Hindi speaking populations especially within India remains limited. The present study was carried out to compare maze production in typical Hindi monolingual and Hindi-English bilingual children. A total of 80 children in the age range of 6- 8 years who were further divided into two groups (40 in each) participated in the study. Narrative samples were audio- recorded and analysed for five maze types - filled pauses, unfilled pauses, repetitions, revisions and abandoned utterances. Group differences were analysed using Chi-square tests. The findings suggested that bilingual children produced significantly higher frequencies of filled pauses and revisions than their monolingual peers, pointing towards greater involvement in real time planning and self-monitoring processes. Repetitions showed a borderline trend in the same direction, whereas unfilled pauses and abandoned utterances did not show significant group differences. These results suggested that different types of disfluencies vary in their sensitivity to bilingual language experience. Overall, the pattern of increased maze production in bilingual children appeared to reflect heightened processing demands rather than an underlying impairment. The findings emphasise the importance of interpreting disfluencies within the child's verbal environment and highlights the need for bilingual-specific normative benchmarks in clinical practice.

Key Words: maze production, bilingualism, narrative fluency, speech disfluencies, language processing

1. Introduction

Maze product provides an important perspective on how children plan, organise, and monitor their speech in real time. During spontaneous speech, especially in tasks like storytelling, children's utterances are never entirely fluent. Rather, they are full of pauses, repetitions, revisions and abandoned utterances. These disruptions, collectively termed as mazes, do not contribute semantic content but instead reflect the

underlying cognitive and linguistic effort needed for language production (Balčiūnienė and Kornev, 2016; Thordardottir and Weismer, 2002).

It is worth noting that mazes are not innately pathological. Infact, they form a natural component of language development and are generally observed in typical children as they manage the demands of speech production. At the same time, their frequency and distribution can offer useful insights into a child's linguistic proficiency and processing efficiency. Therefore, a clear distinction must be made between these typical disfluencies and stuttering, which is characterized by qualitatively different features similar as blocks, prolongations and physical tension (Byrd, 2018). In contrast, mazes are more appropriately viewed as indicators of ongoing planning and self-monitoring processes during speech. Specific maze types, such as filled pauses and revisions, have been shown to reflect active processing demands during speech planning and monitoring rather than breakdowns in fluency (Dollaghan and Campbell, 1992).

Maze production aligns closely with Levelt's model of speech production, which defines speech as a sequence of stages involving conceptualization, formulation and articulation. Disruptions or delays at any of these stages such as difficulty in lexical retrieval or the need to restructure an utterance may manifest as mazes (Peach and Hanna, 2021). Thus, mazes can be viewed not just as random occurrences but rather as systematic reflections of the cognitive load involved in real- time language processing. Within this framework, filled pauses may serve as temporal placeholders during lexical search, while revisions reflect ongoing self-monitoring and repair processes (Conboy and Thal, 2006).

Narrative tasks gives one of the most effective contexts for examining maze production. The construction of a narrative requires children to coordinate multiple linguistic domains including syntax, semantics, pragmatics, and discourse organisation within a coherent frame. As a result, such tasks are particularly sensitive to processing demands. Wordless picture books (e.g., Frog, Where Are You?) are frequently used in this context, as they elicit natural and comparable speech samples across participants (Lim and Hwang, 2009). Within these structured yet flexible contexts, maze production serves as a useful metric for understanding how children manage increasing linguistic complexity. Studies have shown that increased narrative demands are often associated with greater use of disfluency strategies such as repetitions and revisions, particularly when children attempt to maintain fluency under processing pressure (Thordardottir and Brandeker, 2013).

Maze production follows a relatively predictable trajectory. Younger children, especially during the preschool years, tend to produce greater number of mazes as they manage expanding vocabularies and arising grammatical systems (Balčiūnienė and Kornev, 2016). With maturation, as linguistic representations become more stable and processing efficiency improves, the frequency of mazes generally decreases. By the early school years, around 6 to 8 years of age typical children are expected to demonstrate more controlled and efficient speech, with fairly stable levels of maze production (Kaur et al., 2011). Nevertheless, maze occurrence continues to vary depending on task demands especially with longer or more complex utterances.

Children exposed to two languages must continuously manage dual linguistic systems, which involves selecting the appropriate language while suppressing interference from the non-target language. These additional demands can increase cognitive load during speech production and may be reflected in a higher

frequency of mazes (Bedore et al., 2006; Fiestas et al., 2005). Bilingual language processing is further characterized by parallel activation of both languages, leading to lexical competition and increased reliance on executive control mechanisms (Kroll and Bialystok, 2013). Research on bilinguals, particularly Spanish- English speakers, suggests that such children may produce more filled pauses and revisions, likely reflecting the increased effort associated with lexical selection and language control (Byrd et al., 2015; Rojas & Irani, 2020; Rojas et al., 2023). Additionally, bilingual children may use repetitions as a strategy to maintain speech continuity while resolving lexical retrieval demands across competing language systems (Thordardottir and Brandeker, 2013).

Hindi – English bilingualism is widespread, particularly in urban environments where children are frequently exposed to both languages from an early age. Code-switching and code-mixing are common and represent adaptive, sophisticated linguistic behaviours rather than deficits. However, this dynamic linguistic environment also introduces additional processing demands, which may influence patterns of maze production. For example, children may exhibit pauses or revisions when switching between languages or when resolving cross linguistic competition (Eggers et al., 2019). Recent evidence also suggests that bilingual children may rely more on vocalised hesitation markers (e.g., filled pauses) to support ongoing speech planning under increased cognitive load (Arslan et al., 2023).

Despite its relevance, research on maze production in Indian populations, particularly among Hindi-speaking children remains limited. Much of the existing literature has focused on Western bilingual groups, resulting in a lack of culturally and linguistically appropriate normative data (Martinez- Nieto et al., 2023; Taliancich- Klinger & Bedore, 2019). This gap has important clinical implications. In the absence of local norms, speech language pathologists may misinterpret typical bilingual disfluencies as indicators of language impairment or conversely, fail to identify genuine difficulties. This concern has been emphasized in recent clinical literature, which highlights the need for context-sensitive interpretation of disfluency patterns in bilingual populations to avoid over-identification of disorders (Hernandez and Fulcher Rood, 2025).

A systematic understanding of maze production in both Hindi-speaking monolingual and Hindi-English bilinguals is therefore essential. Such work contributes not only to theoretical models of language processing but also to clinical practice. Establishing normative patterns can support more accurate assessment and inform intervention planning, eventually enabling clinicians to distinguish between language difference and disorder more effectively.

NEED OF THE STUDY

Given the limited and uneven body of evidence outlined above, there remains a clear lack of normative data on maze production in Hindi-English bilingual children at the primaryschool level, particularly within urban settings such as Delhi where multilingual exposure is a routine part of development. Much of the available research is disproportionately centered on Western bilingual populations, Spanish-English, for example, which limits its applicability to the linguistic realities of the Indian context. At the same time, the relatively few studies conducted in India either do not include bilingual comparisons or focus on different language pairings.

Maze production, as noted before, is a sensitive marker of real-time language processing and has demonstrated clinical utility in distinguishing typical disfluency from disorder (Byrd et al., 2015). Thus,

establishing age-specific baseline data becomes particularly important for children between 6 to 8 years of age, a period marked by rapid development in narrative and academic language skills.

Developing such evidence has clear practical relevance because it can support speech- language pathologists and educators in making more accurate and contextually grounded decisions, while also contributing to equitable assessment practices. In this regard, the study aligns with broader policy frameworks such as the RPWD Act (2016) and the National Education Policy (2020), both of which emphasize the need for linguistically responsive and inclusive approaches to assessment and intervention in different educational settings.

METHODOLOGY

Aim

The present study aimed to analyse and compare maze production in narrative speech of typical Hindi-speaking monolingual and Hindi-English bilingual children aged 6 to 8 years with an objective to examine specific maze types - filled pauses, unfilled pauses, repetitions, revisions, and abandoned utterances to understand how bilingual experience may shape narrative fluency. The secondary objective was to generate baseline data that may be valuable for both clinical and educational use.

Subjects

Eighty typical children between 6 to 8 years of age from government schools who were evenly distributed across two groups 40 Hindi-speaking monolingual children and 40 Hindi- english bilingual children participated in the study.

Selection was based on reports from both teachers and parents confirming typical developmental milestones and the absence of known speech, language, cognitive or hearing difficulties. For the bilingual group, inclusion required consistent and functional exposure to both Hindi and English in daily life, most commonly Hindi at home and English in school, reflecting natural patterns of bilingual use.

Inclusion and Exclusion Criteria

Children were included if they were enrolled in schools within the Delhi region, fell within the 6-8 year age range, and were reported by both parents and teachers to be typically developing, with no history of speech, language, cognitive or hearing impairments. For children in the bilingual group, regular and functional exposure to both Hindi and English was necessary to insure a representative bilingual profile.

Children were excluded if they had a prior diagnosis of language and speech impairment, speech sound disorder, hearing loss, cognitive delay or neurodevelopmental conditions such as ADHD or autism spectrum disorder. In addition, those who had recently received speech- language therapy, were not residents of Delhi or primarily used languages other than Hindi or English were excluded.

PROCEDURE

Both groups of children who participated in the study were asked to recite an age appropriate and culturally familiar topic given to them from standard textbooks.

The audio recordings were completed in school premises in quiet and well illuminated room. The consent was taken from both parents and teachers before data collection.

All sessions were audio-recorded using the built-in recording system of an HP laptop (model: 15-da0xxx) to ensure clarity and accuracy. The recordings were later analysed for different types of mazes categorised into five types- filled pauses, unfilled pauses, repetitions, revisions and abandoned utterances.

STATISTICAL ANALYSIS

The study used the Chi-square (χ^2) test to examine group differences in the distribution of five maze types, including filled pauses, unfilled pauses, repetitions, revisions and abandoned utterances among 40 typical monolingual Hindi-speaking and 40 Hindi-English bilingual children aged 6-8 years.

Filled pauses were significantly more frequent in bilingual children (87.50%) than in monolinguals (12.50%), $\chi^2(1) = 5.0$, $p = .025$. Revisions also showed a significant group difference, with 68.80% of bilingual children demonstrating revisions compared to 31.30% of monolinguals, $\chi^2(1) = 7.5$, $p = .006$. Repetitions showed a trend towards significance, $\chi^2(1) = 3.23$, $p = .07$, with higher occurence in bilinguals (59.10%) than monolinguals (40.90%).

In contrast, unfilled pauses, $\chi^2(1) = 0.827$, $p = .363$, and abandoned utterances, $\chi^2(1) = 1.27$, $p = .26$, did not differ significantly between the two groups, suggesting that these disfluency types may be relatively similar across language backgrounds. The level of statistical significance was set at $p<.025$.

RESULTS AND DISCUSSIONS

This study compared maze production in narrative speech between monolingual and bilingual children aged 6-8 years across five maze types and results obtained are discussed below.

Table 1

Distribution of Maze Types Across Bilingual and Monolingual Groups

Maze Type	Responses	Bilingual Frequency	Bilingual %	Monolingual Frequency	Monolingual %	Chi-Square Test	p Value
Filled Pauses	Present	7	87.50%	1	12.50%	5.0	0.025*
	Absent	33	45.80%	39	54.20%		
Unfilled Pauses	Present	32	47.80%	35	52.20%	0.827	0.363
	Absent	8	61.50%	5	38.50%		
Repetitions	Present	26	59.10%	18	40.90%	3.23	0.07
	Absent	14	38.90%	22	61.10%		
Revisions	Present	22	68.80%	10	31.30%	7.5	0.006*
	Absent	18	37.50%	30	62.50%		
Abandoned Utterances	Present	20	44.40%	25	55.60%	1.27	0.26
	Absent	20	57.10%	15	42.90%		
***p ≤ 0.025, Significant**							

*Note. *p ≤ .025, statistically significant. Frequencies indicate number of children (out of 40 per group) who produced each maze type. Percentages reflect proportion within row (Present/Absent combined).*

Table 1 summarizes the observed frequencies and percentages of the five maze types across both the groups. A clear group difference is evident in the distribution of filled pauses, which is strongly skewed toward the bilingual group. Specifically, 7 bilingual children (87.50%) produced filled pauses, compared to only 1 monolingual child (12.50%). This difference is statistically significant (p = .025) and suggests that bilingual children may rely more on vocalised hesitation markers (e.g., "um," "uh," or their Hindi equivalents) during narrative production. This pattern likely reflects increased cognitive and linguistic demands associated with managing two active lexicons, including lexical retrieval difficulty and the need to maintain conversational flow during speech planning (Arslan et al., 2023).

Revisions demonstrated the most pronounced between-group contrast. A total of 22 bilingual children (68.80%) produced revisions, whereas only 10 monolingual children (31.30%) did so, yielding a highly significant difference (p = .006). This finding is consistent with previous research indicating that bilingual speakers produce more revisions and self-corrections than monolinguals. Such patterns can be attributed to the parallel activation of both languages, which increases lexical competition and places greater demands on language control mechanisms during speech production (Bedore et al., 2006; Byrd et al., 2015; Kroll & Bialystok, 2013).

Repetitions were observed in 26 bilingual children (59.10%) and 18 monolingual children (40.90%). Although this difference did not reach statistical significance (p = .07), it reflects a trend in the same direction. One possible explanation is that bilingual children use repetition as a compensatory strategy to maintain fluency while resolving lexical retrieval demands across competing language systems (Thordardottir and Brandeker, 2013).

In contrast, unfilled pauses and abandoned utterances did not significantly differentiate the two groups (p = .363 and p = .26, respectively). This suggests that silent pausing and mid-utterance abandonment may be less sensitive to bilingual language experience and may instead reflect general developmental processes common to both groups.

Figure 1

Distribution of Maze Types Across Monolingual and Bilingual Groups

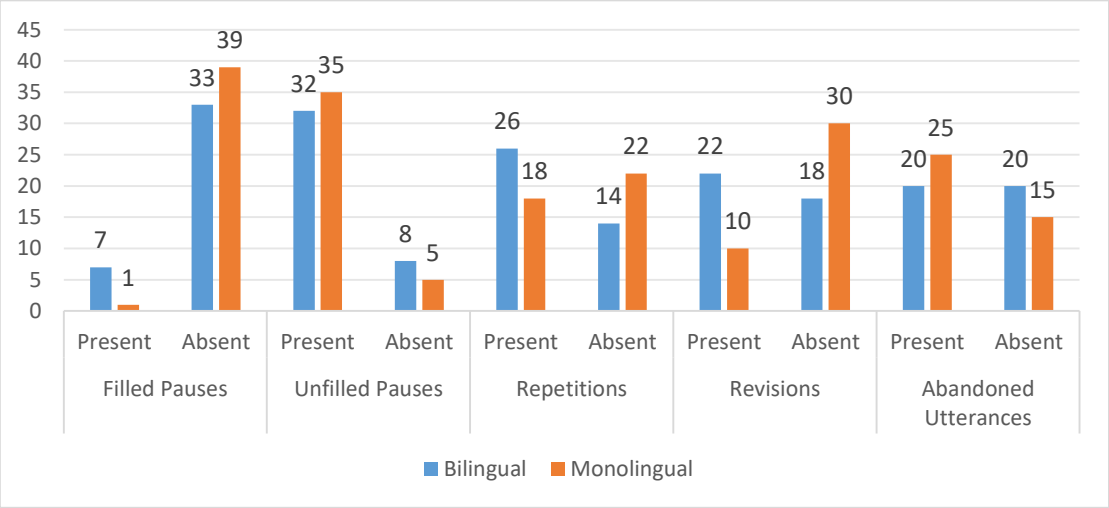

Figure 1 illustrates the distribution of the presence and absence of five maze types namely, filled pauses, unfilled pauses, repetitions, revisions, and abandoned utterancesacross bilingual and monolingual children. Overall, the visual pattern mirrors the trends reported in Table 1, with certain maze types appearing more prominent in one group than the other.

For filled pauses, a clear difference is visible. The bilingual group shows a higher presence (n = 7) compared to the monolingual group (n = 1), while absence is more frequent among monolinguals (n = 39) than bilinguals (n = 33). This contrast indicates a greater reliance on overt hesitation markers among bilingual children during speech planning.

In contrast, unfilled pauses show broadly similar distributions across groups. Monolingual children display a slightly higher presence (n = 35) than bilinguals (n = 32), and the absence values (bilingual = 8; monolingual = 5) follows a comparable pattern. These minimal differences suggest that silent pausing does not meaningfully distinguish between the two groups.

For repetitions, the bilingual group again demonstrates a higher presence (n = 26) relative to monolinguals (n = 18), while monolingual children show greater absence (n = 22) compared to bilinguals (n = 14). This pattern suggests that bilingual children may use repetition more frequently as a strategy to sustain fluency during lexical retrieval.

A more marked group difference is observed in revisions. Bilingual children show a higher presence (n = 22) compared to monolinguals (n = 10), whereas the absence of revisions is greater among monolinguals (n = 30) than bilinguals (n = 18). This distribution reflects increased self-monitoring and reformulation processes in bilingual speech.

For abandoned utterances, the pattern is less distinct. Monolingual children exhibit a slightly higher presence (n = 25) than bilinguals (n = 20), while bilinguals show a greater absence (n = 20) compared to monolinguals (n = 15). These relatively small differences indicate that this maze type occurs at comparable levels across both groups.

Overall, the figure indicates that filled pauses and revisions are more characteristic of bilingual speech, whereas unfilled pauses and abandoned utterances show minimal group differentiation. Repetitions demonstrate a moderate tendency toward higher occurrence in bilinguals.

DISCUSSION

The findings point towards a consistent pattern that bilingual children produced significantly more filled pauses and revisions than their monolingual peers, whereas the remaining maze types did not show meaningful group differences. The higher occurrence of filled pauses in bilingual narrative speech can be understood in relation to increased processing demands associated with managing two active lexicons. In such contexts, vocalised hesitation markers appear to function as strategic tools that support ongoing planning during lexical selection (Conboy & Thal, 2006).

The elevation in revisions among bilingual children is particularly noteworthy. It indicates that Hindi–English bilinguals aged 6–8 years engage more frequently in self-monitoring and reformulation during narrative production compared to monolinguals. This pattern is consistent with theoretical accounts proposing that bilingual language use places greater demands on executive control mechanisms,

particularly for inhibiting the non-target language and maintaining structural accuracy during speech production (Bedore et al., 2006)

Although repetitions did not reach statistical significance ($p = .07$), the observed trend was in the same direction and adds further support to this interpretation. Repetition at the word or phrase level may serve as a temporal buffering strategy, allowing additional time for resolving lexical competition across languages (Thordardottir & Brandeker, 2013).

At the same time, the absence of significant differences in unfilled pauses and abandoned utterances indicates that not all disfluency types are equally influenced by bilingual experience. Behaviours such as silent pausing or abandoning an utterance may be more closely related to general developmental factors and the inherent complexity of narrative tasks, rather than to bilingual status per se (Dollaghan & Campbell, 1992).

These findings have important implications for clinical speech-language assessment. Interpreting disfluencies in bilingual children requires a nuanced and selective approach, focusing on specific maze types rather than treating all disfluencies as equivalent indicators of difficulty. Treating all disfluencies as indicators of impairment risks over-identifying language disorders in bilingual populations. Instead, a more selective and context-sensitive interpretation is needed to distinguish typical bilingual patterns from clinically significant difficulties (Hernandez & Fulcher Rood, 2025).

SUMMARY AND CONCLUSION

The present study explored differences in maze production during narrative speech between typical monolingual Hindi-speaking and Hindi–English bilingual children aged 6 to 8 years. Five types of mazes namely, filled pauses, unfilled pauses, repetitions, revisions, and abandoned utterances were analysed to better understand how children manage real-time language formulation.

The findings point to a consistent and meaningful pattern. Hindi-English bilingual children produced significantly more filled pauses and revisions than their monolingual peers. Both maze types are closely associated with active speech planning, self-monitoring, and reformulation, indicating increased engagement in real-time linguistic processing in bilingual children. This pattern is likely linked to the additional cognitive demands involved in managing two language systems simultaneously. Repetitions showed a marginal trend in a similar direction, suggesting a possible supportive role in maintaining fluency during lexical retrieval, although this difference did not reach statistical significance.

In contrast, unfilled pauses and abandoned utterances did not differ significantly between the two groups, indicating that these forms of disfluency may reflect general developmental processes rather than effects specific to bilingualism.

Overall, the results indicate that maze production should not be viewed as a uniform phenomenon. Certain maze types, particularly filled pauses and revisions serve as more sensitive indicators of the cognitive-linguistic demands underlying bilingual speech. Importantly, such patterns should not be interpreted as evidence of language impairment rather, they should be understood as features of typical bilingual development, shaped by increased processing demands and ongoing language control.

From a clinical perspective, these findings underscore the need for context-sensitive assessment. Speech-language pathologists and educators working in multilingual settings, including India, must exercise caution when evaluating disfluencies in bilingual children. In the absence of appropriate normative standards, there is a risk of misclassifying typical bilingual patterns as disordered. The study therefore highlights the importance of developing bilingual-specific norms to support accurate diagnosis and informed intervention.

Future research involving larger and more diverse samples, along with the use of continuous measures of disfluency and a wider range of narrative contexts, would help refine current understanding of maze production. Expanding this line of research within Indian linguistic settings is particularly important for developing culturally and linguistically valid assessment tools.

To conclude, the study demonstrates that bilingualism influences specific aspects of maze production especially those related to active monitoring and correction during speech and reinforces the view that disfluency, in this context, reflects processing complexity rather than deficit.

CLINICAL IMPLICATIONS

The findings underscore the importance of interpreting disfluencies in bilingual children within an appropriate linguistic context. The increased occurrence of filled pauses and revisions appears to reflect heightened processing demands rather than underlying impairment. This reinforces the need for clinicians to clearly distinguish between language difference and disorder to avoid misdiagnosis.

At the same time, the results indicate that not all maze types are equally informative. This highlights the importance of moving beyond overall frequency counts toward a more qualitative and function based analysis of specific maze patterns. Examining the nature and function of disfluencies can provide more meaningful insight into child's language processing.

The study further points to the urgent need for bilingual specific normative data within Indian populations. Such benchmarks are essential for improving diagnostic accuracy and ensuring that assessment practices remain both valid and culturally appropriate. Narrative tasks, as used in the present study, emerge as particularly effective tools for evaluating real-time language processing in children, given their ecological validity and sensitivity to cognitive-linguistic demands.

From an intervention perspective, the emphasis should be on supporting language organization and processing efficiency rather than attempting to eliminate disfluencies that fall within the range of typical bilingual development. Intervention should therefore prioritise strengthening lexical access, narrative structuring, and monitoring skills, rather than focusing solely on surface-level fluency. Additionally, there is a clear need for enhanced clinician training in bilingual assessment to promote more informed and contextually sensitive clinical decision making.

LIMITATIONS

1. Sample size and geographic scope: The study was carried out with a relatively small sample (40 participants per group) from the Delhi region. As a result, the findings may have limited generalisability to the broader Hindi–English bilingual population across India, particularly in light of regional sociolinguistic variation.

2. Measurement approach: Maze production was analysed using a binary (present/absent) framework, which may have limited sensitivity to finer variations in disfluency patterns. More detailed quantitative measures such as frequency of mazes per utterance could provide a more nuanced and precise understanding of disfluency patterns.

3. Lack of proficiency and dominance measures: Differences in bilingual proficiency, language dominance, and patterns of language use were not systematically assessed. This limits the ability to isolate the specific contribution of bilingual experience to maze production and may have introduced variability within the sample.

FUTURE DIRECTIONS

1. Development of bilingual norms: There is a clear need to establish age-specific and language pair-specific normative data for maze production in Indian bilingual children. Such normative frameworks would significantly enhance differential diagnosis and reduce the risk of misidentification in clinical settings.

2. Longitudinal and cross-linguistic research: Future work should examine developmental changes in maze production over time and extend comparisons to other bilingual groups within the Indian context. This would allow for a more comprehensive understanding of how bilingualism interacts with language development across different linguistic environments.

3. Integration of cognitive and neural level measures: Incorporating cognitive variables such as working memory and inhibitory control, along with neuroimaging approaches, could provide deeper insight into the underlying mechanisms of maze production and its relationship with executive functioning in bilingual children.

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