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EDITED BY
Brechje Antonet Van Osch,
UiT The Arctic University of Norway, Norway

REVIEWED BY
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Linda Jarmulowicz,
University of Memphis, United States
Connie Summers,
Brigham Young University, United States

*CORRESPONDENCE
Pui Fong Kan
puifong.kan@colorado.edu

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Exploring the interplay of semantic knowledge in bilingual children: heritage language and second language

Pui Fong Kan[1]*, Dongsun Yim[2] and Christine Brennan[1]

[1]Department of Speech, Language, and Hearing Sciences, University of Colorado, Boulder, CO, United States, [2]Department of Communication Disorders, Ewha Womans University, Seoul, Republic of Korea

This study investigates the semantic development of heritage bilingual preschool children aged 3 to 5 who acquire Cantonese as their heritage language (HL) at home and English as their community language (L2) in school settings. The research examines how bilingual children organize and access their vocabulary in two distinct languages and how their heritage language influences semantic development in L2. We examined their performance in Word Association Identification Task (WAID) and Word Association Task (WAT) in both languages. Results showed that they perform similarly in WAID in both languages, with higher accuracy in semantically unrelated conditions. The WAT results showed that children had more syntagmatic responses in Cantonese than in English, but had similar paradigmatic responses in both languages. Regression analysis revealed that paradigmatic responses in Cantonese predicted children's English paradigmatic responses. Their English paradigmatic responses were also associated with WAID performance in English. This study contributes to understanding heritage bilingual children's semantic development, with implications for education and language support.

KEYWORDS

bilingual, heritage language, Cantonese, paradigmatic, semantic organization

1 Introduction

This study explores the semantic development of bilingual children who navigate the complex interplay of heritage languages learned at home and a dominant community language acquired in school settings. Semantic development is the ongoing process by which children build and refine their semantic knowledge and organization. In this study, we focus on the semantic organization of young preschool children who learn Cantonese as their heritage language (HL) within their family environments while later encountering English as their second language (L2) in their early childhood education settings. Semantic organization in bilingual children involves complex processes of storing, accessing, and organizing word meanings and concepts in two languages (Sheng et al., 2006; Babatsouli and Ball, 2020). Previous research has shown that bilingual children's language experiences, particularly those involving adult-child interactions and child-directed speech (Clark, 2008, 2017), could

significantly influence how they organize words and concepts across their two languages (Lam and Sheng, 2020). Despite extensive research on semantic development in heritage bilingual children (Bialystok et al., 2010; Yim et al., 2022; Ohana and Armon-Lotem, 2023), there is a limited understanding of how young children who are at the early stage of learning L2 organize words across two distinct languages. The current study aims to bridge this gap by examining young preschool heritage bilingual children aged 3 to 5, actively acquiring Cantonese at home and English at school. This study carries significant importance due to the unique linguistic context of Cantonese and English, characterized by their typological differences and a limited number of cognate words. The findings of this research have the potential to shed light on bilingual children's semantic development in bilingual-bicultural contexts. In the context of children's semantic development, vocabulary is the foundational building block for language and is closely associated with academic success (Carlo et al., 2004; Tong and Tong, 2022). Understanding how bilingual children organize and acquire vocabulary across two distinct languages can provide valuable insights into their overall semantic development. Furthermore, the results of this study have the potential to inform educational practices and provide essential support for bilingual children's language development in both their heritage language and second language contexts.

1.1 Semantic development in heritage bilingual children

To truly "know" a word, a child must develop a representation that includes its phonological form and semantic characteristics. Word acquisition in children involves several stages of development. Initially, establishing an initial semantic representation with the corresponding phonological representation might require only a few exposures (Carey and Bartlett, 1978; Horst and Samuelson, 2008; Swingley, 2010). However, building a deeper and more nuanced understanding of the word requires multiple exposures and usage across various contexts (Ard and Beverly, 2004; Capone and McGregor, 2005; Borovsky et al., 2008; Sloutsky et al., 2017). Word learning involves gradually integrating newly acquired words from episodic experiences into stable lexical representations (Kormi-Nouri et al., 2003; Winocur and Moscovitch, 2011; Tartaro et al., 2021). This process unfolds through repeated interactions with adults, where deictic frames (e.g., gestures and descriptions) play a crucial role in linking new words to specific entities and experiences (Clark, 2017; Clark and Kelly, 2022).

In the study of semantic development among bilingual children, a pivotal aspect is the interactions between HL and L2 (Kan and Kohnert, 2012). Children who acquire their HL from birth develop not only language-specific representations but also fundamental concepts that underpin these representations. This foundational conceptual knowledge in the HL can play a crucial role when these children later learn a new word representation in their L2. Relevant to our investigation is the Revised Hierarchical Model (RHM; Kroll et al., 2010). The RHM posits that bilinguals maintain a shared conceptual store while preserving separate linguistic systems for each of their languages. For young bilingual children, the concepts they learn in their HL can facilitate the acquisition of corresponding words in their L2. The connection between the HL and L2 is not merely lexical but conceptual, implying that understanding a concept in one language aids in grasping its linguistic representation in another language.

Previous research on monolingual young children suggests that when they encounter a new word, it initially represents an episodic experience but must undergo integration into their mental lexicon for effective communication (Sobczak and Gaskell, 2019; Tartaro et al., 2021). Research also showed that monolingual children undergo a developmental transition from initially prioritizing thematic relations, rooted in word co-occurrence patterns, to later emphasizing taxonomic relationships based on shared characteristics (Nelson and Nelson, 1990; Unger et al., 2016; Savic et al., 2023). Initially, children tend to prioritize thematic relations, connecting words like "dog" with "bone" or "bark" because of frequent co-occurrence in their experiences. However, as they develop, they shift toward emphasizing taxonomic relationships, linking "dog" with "cat" based on shared characteristics as animals. Additionally, a parallel shift, known as the syntagmatic-paradigmatic shift, is observed in word association tasks (Nelson, 1977; Wojcik and Kandhadai, 2020). That is, children initially may provide syntagmatic responses, connecting words based on contextual associations. For instance, if given the word "apple," they might respond with "eat." Later in development, they exhibit paradigmatic responses, associating words based on shared categories or meanings. For example, "apple" could lead to responses like "fruit" or "red," emphasizing semantic relationships rather than immediate context. In contrast to the thematic-taxonomic differentiation primarily used to classify object types (i.e., nouns), the syntagmatic–paradigmatic distinction is a broader concept that consists of all form classes (e.g., adjectives, adverbs, nouns, and verbs). Recent research by Wojcik and Kandhadai, 2020 has revealed that the syntagmatic-paradigmatic shift in monolingual children's language development is not abrupt. Children as young as 3 to 5 years old exhibit paradigmatic associations, where they connect words from the same category, and this tendency becomes more pronounced as they grow older.

In contrast to monolinguals, bilingual children's lexical-semantic organization is a dynamic and intricate process that involves the development and integration of two linguistic systems. Evidence shows that simultaneous bilingual children as young as 30 months old develop semantic networks by forming direct connections between concepts with related meanings within and across languages (Jardak and Byers-Heinlein, 2019). The focus of this study is on bilingual children who are raised in environments where the HL is distinct from the L2 used in school and the community. The HL is typically passed down through familial and cultural ties, while the L2 is learned in formal educational settings and interactions with peers. Previous research showed that bilingual children, much like their monolingual counterparts, experience a thematic-to-taxonomic shift in their language development (Peña et al., 2002; Shivabasappa et al., 2019) and a syntagmatic-paradigmatic shift in free word association tasks (WAT) where they are prompted to respond with the first word that comes to mind when presented with a stimulus word (e.g., dog) (Sheng et al., 2006). However, unlike monolinguals, bilinguals could access words from both lexicons when generating associations. For

example, a bilingual child who speaks English and Spanish may associate the English word "dog" with the Spanish word "perro," as well as with other English words such as "bone," "bark," and "house." In a study by Sheng et al. (2006), 12 Mandarin-speaking heritage bilingual children and 12 monolingual English-speaking children were tested using a free word association task in both Mandarin and English. They found that bilingual and monolingual children displayed comparable overall performance in a word association task. In addition, bilingual children exhibited similar and correlated performance in HL and L2. In another study, Sheng et al. (2013) examined syntagmatic-paradigmatic shifts in Spanish-English bilingual children (7;3–9;11) who were asked to generate semantic responses in translation equivalent tasks. The findings revealed that while children were proficient in producing syntagmatic responses (related in context), there were age-related differences in paradigmatic responses. Older children produced more paradigmatic responses than younger children, suggesting a developmental shift toward developing more categorical or meaning-based semantic connections.

Several factors contribute to the syntagmatic-paradigmatic shift in bilingual children's lexical-semantic development. First, sociolinguistic factors, such as the societal status of heritage languages and the linguistic environment within their community, significantly impact semantic knowledge development (Li, 2006; Hollebeke et al., 2022). Differences in language exposure could lead to variations in word acquisition opportunities, favoring high-frequency word acquisition in the dominant language. Second, the cognitive skills of bilingual children, which mature over time, affect their ability to complete semantic tasks. As children age, their cognitive-linguistic system becomes more sophisticated, enabling them to handle more complex language structures and demanding tasks (Bialystok, 1999; Filippi et al., 2022). Third, task difficulties vary depending on the specific semantic task type, with some tasks being more cognitively demanding than others (Lam and Sheng, 2020; Wojcik and Kandhadai, 2020). For instance, tasks involving abstract thinking and evaluating similarities and differences pose greater cognitive challenges than tasks that tap into well-established lexical-semantic concepts (Peña et al., 2002; Sheng et al., 2006). Additionally, the language of testing and the response mode can influence task difficulty, with variations in performance across different semantic task types and languages.

1.2 The current study

This study examines the role of bilingual children's heritage language (HL) in shaping their semantic development in L2. In particular, we focused on heritage bilingual preschool children who learned Cantonese (HL) at home and were at the early stage of learning English (community language; L2) in school settings in the U.S. The unique linguistic contexts of heritage bilingual children present distinctive difficulties when it comes to expanding vocabulary knowledge and organizing semantic concepts (Sheng, 2014; Kang and Yim, 2021). Previous studies showed that semantic organization, which involves the interconnections of words and concepts, plays a crucial role in heritage bilingual children's language development (Sheng et al., 2013; Tong and Tong, 2022). Understanding the developmental processes and factors that influence semantic organization in bilingual children is essential for optimizing their language learning experiences and educational outcomes. Despite the existing body of research on bilingualism (Pena et al., 2003; Sheng et al., 2013), there remains a need to investigate the specific mechanisms and factors that shape semantic organization in younger heritage bilingual children who are in the process of expanding their HL vocabulary while encountering new words in L2-speaking classrooms.

Built from prior research investigating school-aged bilingual children (Sheng et al., 2006), this study examined bilingual children's performance in the Word Association Task (WAT) conducted in both Cantonese (HL) and English (L2). WAT focused on children's semantic development, assessing their ability to recall and generate words based on semantic associations, revealing information about children's syntagmatic and paradigmatic responses in both languages.

The WAT stimuli for school-age children in Sheng et al. (2006) included 72 pairs of translation equivalents, evenly distributed across adjective, noun, and verb categories. These 72 pairs were then divided into two lists of 36 pairs each and these lists were administered to the participants in two parts, with each part containing 18 words. In the experiment, each child had to provide responses to the same word three times consecutively. We want to point out the methodological challenges of using WAT for testing younger preschool children who have limited vocabulary in both HL and L2, potential language loss, and word retrieval difficulties due to language competition (Anderson, 2012; Méndez et al., 2018). Our preliminary data revealed that bilingual preschoolers encountered difficulties when attempting to respond to the target word three consecutive times, as was done in the approach used by Sheng et al. (2006). To address this issue, we modified the task, requiring children to provide just one word that is semantically associated with the target word. Additionally, we introduced a Word Association Identification Task (WAID) designed for young heritage bilingual children in the early stages of L2 acquisition. WAID assessed their ability to identify word relationships by requiring them to point to images that are semantically related to each other. Incorporating both WAID and WAT in both receptive and expressive modalities allowed for a more comprehensive examination of children's semantic organization, administered in both HL and L2. The research questions guiding this study are as follows:

1. How do heritage bilingual preschool children identify semantically-related words in Cantonese and English, considering the presence of two levels of distractors in WAID?
2. In WAT, how do syntagmatic and paradigmatic responses in HL and L2 vary among heritage bilingual preschool children? Does age affect heritage bilingual preschool children's paradigmatic responses in HL & L2?
3. In WAT, are preschool children's paradigmatic responses in their L2 associated with their paradigmatic responses in HL?

4. In WAT, are preschool children's preschool children's paradigmatic responses in their L2 related to their WAID performance?

2 Materials and methods

2.1 Participants

Participants were 42 typically-developing preschool children (25 girls and 17 boys), aged between 3;1 and 5;9 (mean age = 4;6, SD = 0;6). These children learned Cantonese (HL) at home and started to learn English (L2) in school settings in the US. These children were recruited from a Head Start program, which is an early childhood education program in the United States that promotes school readiness for children from low-income families. The majority of teachers in the Head Start program were fluent in both English and Cantonese. Recruiting participants from a Head Start program allowed for the inclusion of children with similar experiences of acquiring English in a school setting. At the time of testing, participants had stronger skills in Cantonese. To be eligible for this study, participants must use Cantonese at home for more than 80% of the time, as reported by their parents. Additionally, to ensure a relatively homogeneous group of participants, we selected children who, according to parental reports, demonstrated greater proficiency in their HL at the time of testing. On average, the participants attended the school for 10.2 months (SD = 7.2). In addition, we collected language samples in Cantonese and English using a wordless book, "Frog where are you?" (Mayer, 2003). The English language samples showed that, on average, children's Mean Length of Utterance (MLU) was 3.36 (SD = 1.4), and their Number of Different Words (NDW) was 36.14 (SD = 16.6). In contrast, the Cantonese language samples revealed that children's average MLU was 5.65 (SD = 1.52), and their NDW was 62.3 (SD = 14.9). Children had significantly longer MLU in Cantonese than in English, $F_{(1, 42)} = 75.58$, $p < 0.001$, and had higher lexical diversity in Cantonese than in English, $F_{(1, 42)} = 85.11$, $p < 0.001$.

2.2 Word association tasks

Two word association tasks—word association identification task (WAID) and word association task (WAT)—were used to examine the semantic knowledge in Cantonese (HL) and English (L2). These tasks were counterbalanced, with half of the participants starting with WAID and the other half with WAT. For both tasks, participants were tested in a quiet room, and these assessments were conducted in Cantonese and English by trained Cantonese-English bilingual research assistants. The order in which these languages were presented for each task was counterbalanced.

2.2.1 Word association identification task

The task consists of 60 items in two different conditions, each presenting a different distractor type to the child (see examples in Appendix A). These items were chosen randomly from a range of children's books within the school, and they were verified by teachers to ensure that the words and pictures aligned with children's experiences and cultural backgrounds. Moreover, to further examine the selected items, we conducted a pilot study with 10 bilingual preschool children (mean age: 3 years 5 months, SD: 7 months) who did not participate in the main study. In the format of a receptive vocabulary test, we presented each item along with 3 other pictures. Each child was asked to point to each item that matched the name they heard in Cantonese. The pilot study revealed a range of 97 to 100% identification rate, suggesting the items were appropriate for this age group.

There were two conditions: (1) Distractor Semantically Unrelated (DU; 40 items) and (2) Distractor Related to the Target (DR: 20 items). In each condition, the child was presented with three images and was instructed to point to two images that were semantically related. For the DU condition, two images were the target pair, chosen to be semantically related (e.g., an orange and an apple), while the third image was not associated with the target pair (e.g., a pencil). For the DR condition, the distractor was semantically related to the target pair but from a different subcategory within the same broader category (e.g., a hotdog). The decision to use 40 items in the DU condition and 20 items in the DR condition was based on a consideration of both task difficulty and participant fatigue. The DR condition was expected to be more challenging due to the presence of semantically related distractors. Pilot data indicated that children took longer to respond and made more errors in the DR condition compared to the DU condition. Using fewer items in the DR condition allows for a more sensitive measure of children's performance on this more difficult task while minimizing fatigue and maintaining engagement. Additionally, presenting too many items, especially in the more demanding DR condition, could lead to decreased motivation in children. Limiting the DR condition helps to ensure that children remain engaged and focused throughout the experiment.

The WAID administration involved an initial phase in which two trial items were presented. In this phase, the examiner presented each trial item without explicitly labeling it and said, "I am going to show you some pictures; please point to the two pictures that are related to each other." During these trial items, examiners were allowed to demonstrate how to correctly point to the two pictures for each trial item, ensuring that the children understood the task before proceeding to the test items. Subsequently, in the testing phase, the examiner presented each test item without providing any verbal labels and repeated the same instruction as in the trial phase. No additional prompts or hints were provided. If a child did not provide a response, the examiner proceeded to the next item.

One point was awarded if the child's response was correct, and no points were given if the response was incorrect. Furthermore, we calculated each child's scores as percentages in each condition and language for analysis. These scores were derived from performance over 40 items in the DU condition and 20 in the DR condition. To ensure reliability, another research assistant, proficient in Cantonese and English, was present when the primary research assistant conducted assessments for 10 children in English and 10 in Cantonese. The scores provided by both research assistants

were then analyzed to assess inter-rater reliability. The agreements between the two coders were 100% for Cantonese and 100% for English.

2.2.2 Word association task

The Word Association Task (WAT; 20 items) was adapted from previous studies (e.g., Sheng et al., 2006). Previous studies using WAT included nouns, adjectives, and verbs; the WAT in this study primarily focused on common objects (nouns). The rationale for using nouns rather than verbs or adjectives in this study was to maintain consistency in the types of stimuli used across WAT and WAID. This consistency ensures that any differences in performance were not related to word categories (nouns, adjectives, or verbs), reducing the potential confounding effect of word type on children's performance.

The WAT (20 items) required children to say a word related to the presented picture (see examples in Appendix A). These items were randomly selected from various children's books available at the school. Teachers confirmed their alignment with children's experiences and cultural backgrounds. This task assessed the children's ability to retrieve and generate words based on semantic associations. The word association task was conducted with Cantonese-English bilingual children on two separate days, with the order of test languages counterbalanced. Different from Sheng et al. (2006), the stimuli included 20 pairs of English and Cantonese translation equivalents of nouns, carefully selected based on common categories such as animals, food, household items, body parts, and clothing. Moreover, to further examine the selected items, we asked 10 bilingual preschool children (mean age: 3 years 5 months, SD: 7 months) to name the 20 pictures. These children were able to name 92%−100% of the items, suggesting the items were appropriate for this age group.

The task started with an example and two trial items. The examiner began by showing a picture and introducing the example item, which was "dog," to ensure that the participants understood the task. During this process, the examiner provided both syntagmatic and paradigmatic word associations. In other words, the examiner displayed the picture and stated "dog," followed by an illustrative explanation that highlighted the association of "dog" with "bark" and also mentioned that "dog" could be associated with "cat". Then, the participant was given a brief practice using two trial items, "car" and "cake." Children were instructed to provide words related to the target noun. If the child did not spontaneously produce such responses during practice, the examiner provided a model (e.g., "car goes with truck"). The examiner moved to the next items if the participant did not respond within 15 seconds or indicated he/she did not know.

Participants' response to each item was coded by trained research assistants proficient in Cantonese and/or English. It was uncommon for our participants to provide multiple responses. In cases where a child uttered more than one response, only the first response was coded. The response for each item was scored as either 1 (correct) or 0 (error) based on the accuracy of the participant's response. Furthermore, we categorized correct responses into two types: paradigmatic and syntagmatic. Paradigmatic responses indicate a categorical association with the presented picture. For instance, if the target picture is "rice," a paradigmatic response might be "food." In contrast, syntagmatic responses reveal a functional or descriptive relationship with the presented picture. For example, a syntagmatic response for the target picture "rice" could be "eat." Errors include no responses, "don't know" indications, repetitions of stimuli or previous responses, responses with unrelated words (e.g., "tiger-banana"), and non-words (e.g., "tiger-flib"). Furthermore, we calculated each child's paradigmatic and syntagmatic responses as percentages for comparative analysis. For instance, if a child had eight responses categorized as paradigmatic and 10 as syntagmatic, the percentages would be 40% for paradigmatic (8/20) and 50% for syntagmatic (10/20).

In addition, we coded language-switching responses that were semantically correct but in the wrong language (e.g., Cantonese words in the English condition). Initially, our original plan was to code only code-switched words [e.g., "食" (sik6) meaning "eat" for the stimulus "rice" in the English condition]. However, we discovered that many participants responded with language-switching at the sentence and phrase levels during the coding process. For instance, when presented with 'rice' in the English condition, many participants would respond in Cantonese with "我哋食飯" (i.e., "we eat rice"). Consequently, we categorized these responses as language-switching at the sentence or phrase level, in addition to language-switching at the word level. The language-switching responses were not included as correct responses in the primary analysis.

Another trained research assistant fluent in Cantonese and/or English performed the initial data coding. Subsequently, a second research assistant, also proficient in both languages, randomly chose 10 samples in English and 10 samples in Cantonese and carried out independent coding. When comparing each point individually, the agreement between their coding averaged 91.5% for English and ranged from 85% to 98%. In the case of Cantonese, the average agreement was 92%, with a range between 92% and 99%.

3 Results

Participants' performance for the WAID and WAT tasks are summarized in Table 1.

3.1 Word association identification task

As shown in Table 1, participants, on average, correctly identified 78% of the items with semantically unrelated distractors in Cantonese and English. Additionally, they identified 68% of the target pairs in Cantonese and 65% in English when the distractors were semantically related to the target pairs. Table 1 summarizes the percentage correct of participants' performance for the distractor-unrelated (40 items) and distractor-related (20 items) conditions.

A linear mixed model was used to examine children's WAID performance. Participant and Age (in months) were treated as random effects to account for individual variability, while WAID Condition (DR vs. DU), Language (HL vs. L2), and the interaction between Condition and Language were included as fixed effects to investigate their impact on WAID scores. The Akaike Information Criterion (AIC) was−170.733, indicating a good fit for the data.

TABLE 1 Word association identification task (WAID) and word association task (WAT) in Cantonese and English.

	Cantonese (HL)		English (L2)	
	Mean (SD)	Range	Mean (SD)	Range
Word association identification task				
Distractor unrelated (DU)	78% (19%)	25%–97.5%	78% (19%)	22.5%–100%
Distractor related (DR)	68% (14%)	25%–95%	65% (0.16%)	15%–95%
Word Association Task				
Paradigmatic	33% (22%)	5%–85%	28.45% (30.65%)	0 % – 100%
Syntagmatic	65% (22%)	15%–95%	30.12 % (30.1%)	0%–90%
Errors	1.6% (3%)	0 %–10%	28.2% (26.8%)	0%–100%
Language-switching	HL to L2		L2 to HL	
- In sentences/phrases	0	0	13.21% (22.5%)	0 – 95%
- In words	0.6% (2%)	0 %–5%	0	0

Results showed that participant ($\beta = 0.02$, $SE = 0.01$, $p < 0.001$) and age ($\beta = 0.001$, $SE = 0.00$, $p < 0.001$) were significant, suggesting WAID scores varied substantially across individuals and age (in months). There was a significant difference between the DR and DU conditions ($\beta = 0.001$, SE = 0.00, $t = 6.4$, $p < 0.001$), suggesting participants exhibited lower WAID scores in the DR condition than in the DU condition. However, there was no significant difference between the two languages in children's WAID scores ($\beta = 0.01$, $SE = 0.01$, $t = 0.55$, $p > 0.05$), suggesting children correctly identified a similar number of pairs in both languages. The Condition x Language interaction did not reach significance ($\beta = 0.01$, $SE = 0.01$, $t = 0.68$, $p > 0.05$), suggesting, the difference in WAID scores between the DR and DU conditions remained consistent across both HL and L2 languages.

3.2 Word association task

Table 1 displays the combined percentages of semantic responses (including paradigmatic and syntagmatic) in Cantonese and English. In the Cantonese condition, participants produced 33% paradigmatic response and 65% syntagmatic response. In the English condition, participants produced 28.45% paradigmatic responses and 30.12% syntagmatic responses. Paired *t-tests* showed that they had more English errors than Cantonese ($t_{(41)} = 5.86$, $p < 0.001$). They also had more sentence/phrase level of language-switching in the English language condition than in Cantonese ($t_{(41)} = 4.12$, $p < 0.001$).

A linear mixed model was used to examine children's WAT performance. Participant and Age (in months) were treated as random effects to account for individual variability, while WAT Response Type (paradigmatic vs. syntagmatic), Language (HL vs. L2), and the interaction between Response Type and Language were included as fixed effects to investigate their impact on WAT scores. The AIC was 45.96, indicating a good fit for the data. Results showed that Participant ($\beta = 0.00$, $SE = 0.00$, $p > 0.05$) and Age ($\beta = 0.00$, $SE = 1.16$, $p > 0.05$) were not significant, suggesting individual and age-related differences may play a less prominent role in WAT performance. Results also showed that Language was significant ($\beta = 0.08$, $SE = 0.02$, $p < 0.001$), suggesting that children produced more responses in the Cantonese condition than in the English condition. Response Type was significant ($\beta = -0.06$, $SE = 0.02$, $p < 0.01$), suggesting children produced fewer paradigmatic responses than syntagmatic responses. In addition, the Response Type x Language interaction also reached significance ($\beta = -0.06$, $SE = 0.02$, $p < 0.01$). Participants produced more syntagmatic responses in the Cantonese condition, while there was such difference in the English condition.

3.3 Relationships between NDW, WAID, and WAT

In our analytical approach to examining the relationships between children's existing language skills, WAID (related and unrelated distractor conditions in HL and L2), and WAT (paradigmatic and syntagmatic aspects in HL and L2), we conducted a two-step analysis. The correlation results served as a foundation for our subsequent regression analysis. Firstly, we explored the connection between NDW (Number of Different Words) and MLU (Mean Length of Utterance) for each language, considering these variables as indicators of children's existing language skills. Our preliminary examination revealed a significant correlation between MLU and NDW in both Cantonese and English (Cantonese: $r = 0.46$, $p < 0.001$; English: $r = 0.68$, $p < 0.001$), consistent with previous studies (Kohnert et al., 2010). It is important to note that the inclusion of highly correlated predictors (e.g., MLU and NDW) in the regression model could lead to multicollinearity and could affect the reliability and interpretability of the results (Montgomery et al., 2012). To avoid this issue, we chose to focus on NDW as it primarily captures lexical diversity and has a closer connection to word-level semantics, aligning better with our research goals. Secondly, Pearson correlation analysis was used to explore the relationships across the WAID (related and unrelated distractor conditions in HL and L2), WAT (paradigmatic and syntagmatic in HL and L2) as well as NDW in HL and L2.

TABLE 2 Relationships between age, lexical diversity, WAID, and WAT results.

	1	2	3	4	5	6	7	8	9	10
1. Age (in months)	–	–	–	–	–	–	–	–	–	–
2. L2 NDW	−0.26	–	–	–	–	–	–	–	–	–
3. HL NDW	−0.21	0.28	–	–	–	–	–	–	–	–
4. L2 Unrelated Distractor	0.39**	−0.37*	−0.18	–	–	–	–	–	–	–
5. L2 Related Distractor	−0.01	−0.26	−0.06	0.49**	–	–	–	–	–	–
6. HL Unrelated Distractor	0.38*	−0.37*	−0.22	0.8**	0.26	–	–	–	–	–
7. HL Related Distractor	0.11	−0.12	−0.10	0.28	0.36*	0.57**	–	–	–	–
8. L2 Paradigmatic	−0.19	0.4**	0.23	−0.34*	0.06	−0.27	−0.02	–	–	–
9. HL Paradigmatic	−0.11	0.49**	0.25	−0.33*	−0.27	−0.17	−0.09	0.75**	–	–
10. L2 Syntagmatic	−0.04	−0.37*	−0.12	0.17	0.21	0.04	0.03	−0.6**	−0.76**	–
11. HL Syntagmatic	0.08	−0.47**	−0.23	0.29	0.26	0.14	0.07	−0.74**	−0.99**	0.79**

NDW, number of different words. All variables from WAID and WAT, including paradigmatic, syntagmatic, related, and unrelated distractor conditions, were percent correct. * < 0.05, ** < 0.01, *** < 0.001.

Table 2 summarizes the results. There were significant correlations within each WAID and WAT. Of interest in this study was the positive correlation between paradigmatic percentages in HL and L2 in the WAT ($r = 0.75$, $p < 0.01$), indicating that children who produced more paradigmatic responses in HL also produced more paradigmatic responses in L2. Additionally, NDW in English was positively correlated with the paradigmatic responses in HL and L2 ($r = 0.4$, $p < 0.01$, and $r = 0.49$, $p < 01$, respectively).

Given the complex relationships between different language measures and age revealed in the correlation matrix, a backward regression model was used to analyze children's paradigmatic responses in English (Montgomery et al., 2012). The predictors entered into the model include age (in months), NDW in Cantonese and English, the WAID percent correct in DR and DU conditions in both languages, the Paradigmatic percentage in Cantonese, and the Syntagmatic percentage in Cantonese and English. During backward elimination, variables with a probability of F-to-remove greater than or equal to 0.1 were automatically excluded from the model. The elimination process ended when none of the remaining variables met the removal criterion ($p < 0.1$). This method allowed for a flexible, data-driven exploration of potential predictors while mitigating the risk of model overfitting. By stepwise removal of statistically insignificant variables, the backward regression ensured a parsimonious model focused only on the most relevant factors influencing paradigmatic responses.

Table 3 presents the key statistics from the backward regression models. The change in R^2 across the backward regression models reveals a gradual refinement of the key predictors explaining children's paradigmatic responses in English. Starting with an initial R^2 of 0.71 in Model 1, each removal of statistically insignificant variables led to a small decrease in explained variance. In the final model, three key predictors, Cantonese Paradigmatic, English-unrelated distractor, and English related distractor, retains a substantial R^2 of 0.7. The results demonstrate that these core factors capture almost as much variance as the more complex initial model. The results suggest that while some initially included predictors provided minor contributions, the final model efficiently explains the majority of variance.

TABLE 3 Summary of the backward regression models.

Model	*R*	R^2	*SE*	*F*	*p*
1	0.84	0.71	0.19	7.59	<0.001
2	0.84	0.71	0.19	8.71	<0.001
3	0.84	0.71	0.19	10.10	<0.001
4	0.84	0.71	0.18	11.89	<0.001
5	0.84	0.71	0.18	14.25	<0.001
6	0.84	0.71	0.18	17.55	<0.001
7	0.84	0.71	0.18	22.20	<0.001
8	0.84	0.70	0.18	29.71	<0.001

Cantonese Paradigmatic in WAT, English unrelated distractor (DU), and English related distractor (DR) conditions were significant in the final model (see all models in Appendix B). The model showed that age was not a significant predictor. However, children's paradigmatic response in Cantonese was the strongest predictor of children's paradigmatic responses in English ($\beta = 1.1$, $SE = 0.14$, $t = 8.11$, $p < 0.001$). Holding all other variables constant, a one-unit rise in Cantonese paradigmatic percentage points corresponds to a 1.1-unit increase in the child's English paradigmatic percentage points. In addition, children's performance on the related distractor condition of the WAID in English predicted their paradigmatic responses in English ($\beta = 0.82$, $SE = 0.2$, $t = 4.04$, $p < 0.001$), suggesting that when children performed better in the DR condition, it was associated with higher paradigmatic responses in English. In contrast, their performance on the unrelated distractor condition of the WAID in English was negatively associated with their paradigmatic percentage in English ($\beta = -0.49$, $SE = 0.17$, $t = -2.82$, $p < 0.01$), suggesting that children's strong performance in the DU condition in English was linked to lower paradigmatic responses in English.

4 Discussion

This study explores the impact of heritage language on the semantic development of bilingual preschool children, specifically those learning Cantonese (HL) at home while acquiring English (L2) at school in the U.S. Our study builds upon prior research that underscores the pivotal role of semantic organization in the language development of these heritage bilingual children (e.g., Sheng et al., 2013). In this study, we recruited 42 typically-developing preschool children (mean age = 4;6, SD = 0;6) who had been exposed to L2 in school for an average of 10.2 months (SD = 7.2). This study utilized two word association tasks to assess semantic organization in HL and L2. Two semantic tasks were used to examine children's semantic knowledge: The Word Association Identification Task (WAID) and the Word Association Task (WAT). There are several important findings from this study. First, in the WAID, participants showed an average accuracy of 78% in identifying items with semantically unrelated distractors in Cantonese and English. However, their accuracy dropped to 68% in Cantonese and 65% in English when the distractors were semantically related to the target pairs. The distractor-related condition was found to be more challenging due to the influence of semantic associations between the distractors and the targets. Second, in the WAT, participants had some paradigmatic responses in both languages. As expected, they did not demonstrate a syntagmatic-paradigmatic shift. In contrast to the absence of a language effect in WAID, participants produced more syntagmatic responses than paradigmatic responses in the Cantonese condition, while there was no such difference in the English condition. Additionally, there were significantly more errors and instances of sentence/phrase-level language-switching when responding in English compared to Cantonese. Thirdly, there was a relationship between children's semantic knowledge measured by WAID and WAT. Notably, the paradigmatic percentage in Cantonese primarily predicted children's paradigmatic responses in English. The related distractor condition of WAID in English also predicted participants' paradigmatic percentage in English. However, it was negatively associated with their performance in the unrelated distractor condition of the WAID in English.

4.1 Semantic organization in bilingual preschool children

The current study reveals the complexity of children's semantic organization in HL and L2, as measured in two word association tasks. In the WAID, the correct response involves multiple cognitive processes. Firstly, participants must recognize the words associated with the presented images. Subsequently, they must discriminate between the correct target words and a distractor word, taking into account semantic relationships for differentiation. Finally, a decision-making process ensues, guiding them to select the correct response based on the semantic association between the target words and the distractor. The WAID results showed that heritage bilingual children identified a similar number of items in both languages despite having stronger Cantonese skills at the time of testing, and older children tended to perform better than younger children. The findings are consistent with the results in Peña et al. (2002), in which Spanish-English bilingual children performed similarly on a taxonomic word generation task in both Spanish and English, and older children demonstrated enhanced proficiency in generating taxonomic responses. However, the decrease in accuracy to 68% in Cantonese and 65% in English when faced with semantically related distractors suggests the influence of semantic associations between words in both languages. The findings indicate that bilingual children at this stage of development may face some challenges in differentiating between closely related concepts in their heritage language and second language, which is a critical aspect of their semantic development. The lack of significant differences in WAID scores between Cantonese and English in the condition with semantically related distractors (DR) suggests that at this early stage of language development, bilingual children may rely on their cognitive and conceptual abilities to navigate semantic associations, leading to similar performance across both languages. As they continue to develop their language skills, differences in semantic organization between their heritage language and second language may become more apparent. Future longitudinal studies are needed to verify the hypothesis.

Unlike the WAID task, the WAT task engages a different set of cognitive processes. Initially, bilingual children retrieve the target word prompted by the examiner and proceed to discern the meaning of the target word. Then, they select and produce the word most closely associated with the word they heard in the correct language (Costa et al., 2006; Abutalebi and Green, 2008). As children accumulate more experience with both languages, it is anticipated that their performance in the WAT task will improve (Peña et al., 2002; Sheng et al., 2013). Of interest in this study are the paradigmatic responses because they provide insights into semantic organization. The WAT results showed that our participants, who had more Cantonese experiences, had more syntagmatic responses than paradigmatic in the Cantonese condition while produced similar number of paradigmatic responses in both languages. One explanation for the higher occurrence of syntagmatic responses in Cantonese compared to English can be attributed to children's experiences in HL and L2. As shown in previous studies (e.g., Ard and Beverly, 2004), learning a new word requires multiple exposures across various situations. These experiences in word learning serve to strengthen the representation of the new word, facilitating its integration with other words that exhibit similar semantic characteristics. In our study, our participants were exposed to Cantonese from birth and began learning English in school settings. As a result, they encountered Cantonese words much more frequently and applied them in in a broader array of situations compared to English. Our data showed that they were more inclined to produce syntagmatic responses in Cantonese, reflecting their extensive exposure and familiarity with the language and cultural relevance. In contrast, participants were still acquiring vocabulary in L2 and may not have the same rich experience in L2 to generate syntagmatic associations which are associate with experiences. Their limited experiences in L2 might limit their ability to generate syntagmatic associations based on experiences

in L2 contexts. Regarding the comparable number of paradigmatic responses across languages, one explanation could be attributed to cross-linguistic influence on their semantic processing (Kroll et al., 2010). The shared conceptual knowledge may facilitate the use of similar semantic organization strategies across both language conditions during WAT. Further research, utilizing a larger sample and a longitudinal design, is necessary to confirm this hypothesis and gain a deeper understanding of bilingual language processing dynamics.

The WAT results did not show a syntagmatic-paradigmatic shift, in contrast to previous studies that examined older school-aged children (Sheng et al., 2006, 2013). The absence of a syntagmatic-paradigmatic shift is not surprising, as previous research has demonstrated that monolingual children typically begin to produce more paradigmatic responses at around the ages of 6 to 9 years old (Sloutsky et al., 2017). While there is evidence indicating that heritage bilingual children may have an advantage in producing paradigmatic responses, this shift typically does not occur until after preschool age (Sheng et al., 2006). Another explanation may be related to methodological differences. Unlike previous studies that included nouns, adjectives, and verbs in their WAT stimuli, our study specifically concentrated on nouns. This methodological difference could have influenced the nature of semantic associations elicited from the participants. Nouns, primarily representing concrete objects, may inherently lead to more syntagmatic responses, given their immediate contextual associations. Other unexplored factors, such as task difficulty and cultural influence, could also contribute to children's paradigmatic responses. Further research is needed to examine the factors influencing the development of the syntagmatic-paradigmatic shift in bilingual preschool children.

Another important finding from WAT results is the instances of language-switching, indicating their natural inclination to switch between languages. In contrast to the older bilingual children in Sheng et al. (2006), our preschool participants did not typically seek permission or explicitly express their lack of knowledge regarding specific English words. At the word level, we found that instances of language-switching were relatively rare. Specifically, bilingual children displayed a preference for maintaining language consistency when selecting individual words. Switching from Cantonese to English at this level occurred in only 0.6% of cases while switching from English to Cantonese was virtually non-existent at 0%. The results suggest that bilingual children predominantly relied on words from their stronger language to convey specific concepts when needed. However, sentence and phrase-level language-switching accounted for 13.2% of responses from English to Cantonese while 0% from Cantonese to English. For instance, when presented with an English word like "rice," some children effortlessly transitioned to Cantonese sentences such as "我哋食飯" (i.e., "we eat rice"). One possible explanation is their inclination to utilize Cantonese to express their thoughts. The language-switching instances suggest that young bilingual learners utilize sentences and phrases from their stronger language (i.e., Cantonese) to express ideas when confronted with vocabulary challenges in their weaker language (i.e., English).

4.2 Within- and crosslinguistic associations in the word association tasks

The results of this study revealed complex within- and crosslinguistic associations between the two association tasks (WAID and WAT). One key finding of our study is the association between the WAT paradigmatic responses in Cantonese and English. This finding suggests that how bilingual children organize their knowledge of Cantonese words influences how they organize their knowledge of English words. The Revised Hierarchical Model (RHM) posits that bilingual children have a shared conceptual store for both languages (Kroll et al., 2010). The crosslinguistic association in paradigmatic responses suggests that the representations of words in a bilingual child's heritage language (HL) can influence their representations of words in their second language (L2). One explanation is that the heritage bilingual participants in this study could generate paradigmatic responses in English because they already had a strong understanding of the underlying concepts associated with those words in Cantonese. It is also plausible that how bilingual children organize their knowledge of Cantonese words appears to have a direct influence on how they organize their knowledge of English words. While it is important to note that no two languages possess identical semantic structures, the presence of a shared conceptual store suggests that the cognitive representation of words in one language can significantly impact the organization and understanding of words in the other language. This finding offers valuable insights into the complex interplay between bilingualism and semantic organization.

Another interesting finding is the complex relationships between children's performance in the WAID and the WAT in English. Specifically, we observed both positive and negative within-language relationships. On the one hand, there was a positive association between children's performance in WAID with related distractors and their ability to provide paradigmatic responses in WAT in English. This relationship suggests that children who excel at suppressing interference from related distractors (DR) in WAID also tend to perform better at making paradigmatic connections in WAT. This positive relationship can be attributed to the shared cognitive processes involved in both tasks. In both WAID and WAT, children need to access their semantic networks and establish connections between related words. When children are adept at suppressing interference from related distractors in WAID, they demonstrate proficiency in focusing on the target pair, which aligns with the demands of WAT that require a certain level of concentration on the target word. On the other hand, we also found a negative relationship between children's performance in WAID with unrelated distractors and their paradigmatic responses in WAT in English. In the DU condition of WAID, children are required to discern the two semantically related pictures among a set of three, while WAT necessitates the flexibility to shift across related concepts within the same category, reflecting a cognitive inclination toward flexible exploration. Results showed that children who excelled in the condition with unrelated distractors in WAID may encounter challenges when generating paradigmatic responses in WAT. From a cognitive processing perspective, this finding may be influenced by various factors, including the children's prior experience with the English language and the potential competition

between the two languages during WAT (Lam and Sheng, 2020). It is plausible that their familiarity with Cantonese, a language in which they have a stronger foundation, may temporarily affect their ability to retrieve and generate semantically related words when tested in English, leading to more errors or a lack of responses in WAT. However, it is important to approach this interpretation with caution, as individual factors and the dynamic interplay between cognitive processes and language experience can vary significantly among children. Further research with a larger sample size is needed to establish a clear link between bilingual children's language experience, cognitive processing, and task performance.

4.3 Limitations

While the current study sheds light on the intricate relationship between heritage language and second language in the semantic development of bilingual preschool children, there are several methodological limitations. Firstly, our sample size was relatively small, focusing on only one group of children who learn Cantonese as HL and English as L2. A larger and more diverse participant pool could provide a more comprehensive understanding of the dynamics between a semantic organization in heritage and second languages. Secondly, participants in this study were situated in San Francisco, a community with a substantial population of Cantonese speakers, thus benefitting from robust community support. Children residing in regions where Cantonese had less support may yield divergent outcomes. Future research should consider investigating community support for a more comprehensive understanding of Cantonese-English bilingual children's semantic development. Thirdly, this research measured children's semantic organization using only two word association tasks (WAID and WAT). However, no norming tests were carried out on the stimuli in both languages to validate their suitability for the targeted age group and cultural context despite having tested children's responses during the stimulus development phase. Future studies should include a broader range of semantic tasks, and further efforts should be made to standardize the items, particularly for heritage languages, in order to gain a more comprehensive understanding of semantic organization. Lastly, the study's cross-sectional design limited our ability to draw causal inferences regarding the relationship between heritage language proficiency and semantic development in the second language. Future research using a longitudinal design would be informative for capturing the developmental trajectory over time.

4.4 Clinical implications

The findings of this study underscore the important role played by the heritage language in shaping semantic organization in the second language. The interconnectedness between the two languages carries significant clinical implications, particularly in educational settings. Educators and speech-language professionals working with heritage bilingual children should recognize the valuable role of the heritage language as a scaffold for second language learning. By acknowledging the cognitive processes involved in this crosslinguistic interaction, educators can design more effective strategies and interventions (e.g., coaching parents to use HL at home) to support bilingual children's semantic development in both languages.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the University of Colorado Boulder. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

PK: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. DY: Conceptualization, Methodology, Writing – original draft, Writing – review & editing. CB: Methodology, Resources, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/flang.2024.1325344/full#supplementary-material

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