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Language Brokering and Bilingual Cognition: The Influence of Context on Bilingual Cognitive Processes

DISSERTATION

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by

Guadalupe Aileen Mendoza

Dissertation Committee:
Distinguished Professor Judith F. Kroll, Chair
Professor Elizabeth D. Peña
Assistant Professor Anne L. Beatty-Martínez

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DEDICATION

This dissertation is dedicated to my parents who gave me everything so I could be anything.

A mis padres.

Por su amor incondicional, su paciencia infinita y por ser el pilar fundamental de mi vida.
Gracias por enseñarme que con esfuerzo y perseverancia todo es posible.

Este logro es tanto de ustedes como mío.

"El que no siembra no cosecha."

To the immigrants who crossed borders, and to their children who learned how to build bridges:
this work is proof of the seeds you planted.

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VITA

Guadalupe Aileen Mendoza

2026 PhD in Education, UCI

EDUCATION

2015-2019	B.A. in Psychology with minor in Ethnic Studies University of California, Riverside
2021-2024	M.A. in Education - Emphasis in Human Development in Context University of California, Irvine
2021-2026	Ph.D. in Education - Emphasis in Human Development in Context University of California, Irvine

FIELD OF STUDY

Bilingualism and psycholinguistics

PUBLICATIONS

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ABSTRACT OF THE DISSERTATION

Language Brokering and Bilingual Cognition:
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Guadalupe Aileen Mendoza
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Distinguished Professor, Judith F. Kroll Chair

Language brokering, the informal translation and interpretation that many heritage bilinguals perform for their families and communities, offers a rich context for understanding how early life experience shapes language processing. Past research has linked brokering to more integrated conceptual representations across bilinguals' two languages and cognitive flexibility, but little is known about how variability in brokering experiences relate to individual language use patterns. This dissertation examines how language brokering shapes bilingual language processing and regulation and proposes brokering as an experience that refines cross-language integration and the cognitive mechanisms that support it.

Study 1 tested this across Spanish-English and Mandarin-English heritage bilinguals in California and Spanish-English sequential bilinguals in Mexico. Brokering was unrelated to picture naming, while childhood, not adulthood, brokering selectively predicted semantic interference resolution during translation recognition among Spanish-English heritage bilinguals. Study 2 used EEG with Spanish-English heritage bilingual brokers to localize this effect via the N400 and Late Positivity Component. Both showed robust semantic interference effects, but semantic-level brokering moderation was absent neurally. Instead, brokering reorganized neural responses to form-related distractors, more extensively for adulthood than childhood brokering. These findings indicate brokering exerts a selective influence on bilingual processing that is also determined by the developmental time frame in which brokering takes place.

CHAPTER 1: General Introduction

1.1 Overview

Language is a dynamic adaptive system that serves as an integral part of our social functioning as humans. As such, there are many life circumstances in which knowing and using more than one language is the optimal condition to achieve one's communicative goals. Although more of the world's speakers are bilingual than monolingual, it is only relatively recently that research has addressed the consequences of bilingualism for understanding language processing and the cognitive mechanisms that support it (Kroll & Bialystok, 2013; Bialystok & Craik, 2022). We have learned that a bilingual is not two monolinguals in one (Grosjean, 1989). Individuals come to be bilingual in a multitude of ways. Some people learn two languages simultaneously from a young age, while others learn two languages sequentially by acquiring a first language (L1) early in life and then learning a second language (L2). Recent research has centered on the variation in bilingual language experiences and its consequences for the bilingual mind and brain (Beatty-Martínez et al., 2020; de Bruin, 2019; Kroll et al., 2018). A discovery at the heart of this research is the finding, now replicated many times, that the two languages are active and interacting even when bilinguals speak one language alone (Blumenfeld & Marian, 2013; Starreveld et al., 2014; Bobb et al., 2020). Using both behavior and cognitive neuroscience, recent studies have asked how the two languages come to be used without interference.

Although bilingualism exists in many forms, there are some bilingual experiences that are common but understudied. In the US, the most prevalent form of bilingualism is heritage bilingualism (American Academy of Arts and Sciences, 2017), where an individual first acquires a home language and then the societal language (i.e., English in the US) in which they typically

become dominant. Heritage bilinguals are often monolingual in the home language during the early years of life but then acquire English as the L2 upon entry into school where they typically experience a language dominance shift (Kupisch & Rothman, 2017) such that English becomes their dominant language. Heritage bilinguals use their two languages dynamically as they navigate home, school, and social environments. But for children whose caregivers are functionally monolingual in the home language, they may also become language brokers. Language brokering is a distinct bilingual practice in which individuals act as informal translators between speakers of a dominant societal language and a less widely spoken home language. This role is often undertaken by children of immigrants, involving tasks such as translating conversations, documents, and providing language support in medical settings. Notably, serving as a language broker is deeply influenced by the context and is not a role that is undertaken by all bilinguals; researchers have asserted that "speaking a language spontaneously and translating a language are functionally distinct activities" (Green, 1998). While some past research has focused on capturing the long-term outcomes of early life language experiences in which children are cut off from their first exposed language (e.g., international adoptees, Pierce et al., 2016; childhood overhearers, Au et al., 2008), there have only been a few studies on the consequences of language brokering (e.g., López et al. 2020).

Despite its prevalence, there remains a notable gap concerning the cognitive and linguistic consequences of brokering and its persistence into adulthood. In this dissertation, I investigated the spectrum of language brokering experiences and its influence on language processing and regulation. While past research has demonstrated more unified semantic representations across brokers' two languages (López et al., 2018), here I examined ways that the early life experience of translating itself creates enduring consequences for language processing and cognition. Using

behavioral and electrophysiological (i.e., event-related potentials; ERPs) methods, I assessed how heritage bilinguals with diverse language brokering experiences perform on a set of linguistic and cognitive tasks. Critically, to my knowledge, this is one of the first studies to date that assesses language brokering utilizing ERPs in addition to behavior. I hypothesized that the act of brokering incurs significant implications for how a bilingual uses and manages their two languages, in a way that is functionally distinct from just language proficiency.

1.2 Impacts of Early Life Language Experiences

From infancy to old age, bilingualism has been shown to induce profound and enduring effects. Although there are often assumptions that bilingualism is only observable once children begin to speak, there is overwhelming evidence that during the first year of life there are notable differences between monolingual and bilingual infants. Bosch and Sebastián-Gallés (1997) reported that infants as young as four months old who are exposed to bilingual language input develop sensitivity to both languages in their environment, enabling them to distinguish between the two languages even when they share similar rhythms. Other research on bilingual infants highlights significant early developmental impacts of exposure to two languages. For instance, studies using brain imaging techniques such as magnetoencephalography have shown that bilingual infants exhibit greater flexibility in distinguishing phonemes in comparison to monolinguals, and bilinguals activate brain areas associated with executive function, suggesting benefits beyond language acquisition even in the earliest stages of life (Ferjan Ramírez et al., 2017). Early exposure to multiple languages appears to enhance infants' speech perception abilities, allowing them to discriminate between the two languages even before they start speaking, a phenomenon proposed as the “Perceptual Wedge Hypothesis” (Petitto et al., 2012). Like a wedge which physically holds a door open, the hypothesis is that input to multiple

languages in early life holds the "door" of language sensitivity open in childhood, affecting not only the languages to which babies have been exposed but also their ability to learn non-native contrasts.

In early childhood, bilingualism has been linked to advantages in both linguistic and cognitive domains. Bilingual preschoolers demonstrate faster vocabulary acquisition and improved executive attention in comparison to their monolingual peers (Yang et al., 2011). Similar advantages appear in kindergarten-aged children (Carlson & Meltzoff, 2008). While bilingual children have been reported to have smaller vocabularies than monolinguals, the habitual use of two languages is associated with long-term benefits in executive functions, potentially mitigating socioeconomic disparities in cognitive development (Hartanto et al. 2019). Similarly, dual language education and exposure has been associated with profound benefits for executive functioning abilities in bilingual children (Esposito & Barker-Ward, 2013). It is important to note that there are some who have argued that these consequences may not be observed reliably (Gunnerud et al., 2020). Critically, there is very little evidence to suggest any disadvantages in cognitive abilities (Keith & Nicoladis, 2013). Of importance in the research to be reported here is that bilingualism affects language development from the beginning of life and at least some early life experiences appear to have enduring consequences. To my knowledge, no existing research has asked how specific features of language use early in life may themselves create these consequences.

Examining diversity in early life language experiences provides a perspective on the impacts of bilingualism across the lifespan. Although traditional accounts of language acquisition emphasize constraints associated with a critical or biologically sensitive period in early childhood (Lenneberg, 1967; Johnson & Newport, 1989), more recent research, particularly

using neurocognitive methods, has shown evidence for plasticity in language development that extends beyond the earliest years of childhood (e.g., Caldwell-Harris & MacWhinney, 2023; Steinhauer, 2014; Pliatsikas, 2020). Some of the most provocative examples of the consequences of early language experiences that extend into young adulthood come from unique populations who have exposure to a language in early life and are subsequently cut off from it. Studies on international adoptees and childhood overhearers highlight the enduring effects of early language exposure. Despite minimal active use of their birth language, international adoptees show residual neural traces and potential for relearning their native language in later years (Choi et al., 2017; Pierce et al., 2016). Similarly, childhood overhearers of languages spoken at home exhibit unique language learning profiles, suggesting prolonged effects of early exposure on language phonology (Au et al., 2002; Oh et al., 2019). The focus on early experiences also prompts investigation into how variation in exposure may influence later language acquisition. For instance, as I have noted, heritage speakers in the United States often transition from a home language to the dominant community language during early schooling, impacting their linguistic proficiency and literacy in the home language (López et al., 2019; Polinsky & Scontras, 2020).

It is important to consider that early life language experiences, such as that of international adoptees and childhood overhearers, are passive in nature, related to exposure to the ambient language speech environment. In comparison, the experience of language brokering is active, requiring production of both languages. Language brokering is also distinct in that it is an experience that typically persists in life and does not have an abrupt cut off as these other experiences do. If we can see profound changes to the brain and behavior when an experience is limited to just the earliest stages of life, the idea that language brokering, which persists later in life, may incur long-term consequences seems likely. Research on early bilingual experiences

underscores its profound impact on the development and tuning of language processes from infancy to adulthood. Understanding these influences is essential for elucidating the contexts that shape the bilingual mind and brain in adolescence, young adulthood, and beyond.

1.3 Language Brokering

Research on language brokering has a long history prior to its focus on language processing specifically. An early and widely accepted characterization of language brokering today draws on the definition provided by Tse (1996), who described the practice as one in which children "facilitate communication between two linguistically and/or culturally different parties." The term itself, however, originated earlier, in a case study of Mexican-American bilingual children in classroom settings, where children took on the role of brokering for peers who were less proficient in English. De la Luz Reyes et al. (1993) found that "Chicano children took more pride in their bilingual skills as the role of 'language brokers' took on importance and prestige in the class." Given these origins in the classroom and the home settings, it is unsurprising that the focus of language brokering research has predominantly centered on the experiences of child language brokers and produced a substantial body of work on their outcomes.

Beyond these initial frameworks, language brokering has also been theorized through two lenses that help explain not just what brokering is, but why it happens and what kinds of processes it constitutes. The first framework is rooted in sociocultural theory and views brokering as a form of environmentally situated literacy practice. Child brokers are not simply transferring words between languages but rather they actively summarize, contextualize, and adapt meaning for their audience; this is a process that has been called "para-phrasing" (Orellana,

Dorner, & Pulido, 2003). This framing positions brokering as cognitively and linguistically demanding work embedded in everyday family activity, rather than a passive act of translation.

The second lens draws on family systems and acculturation-gap theory, which posits that children of immigrants often acculturate to the host culture and language more quickly than their parents (Telzer, 2011). This produces a gap that can shift family power dynamics, so within this framing, brokering is a visible manifestation of children taking on developmentally advanced responsibilities within the family; this act is often described as parentification. Taken together, these two lenses suggest that brokering can be understood as a multifaceted linguistic, cognitive practice and socioemotional process. This nuance motivates the present dissertation's attention to both cognitive outcomes and the broader experiential context in which brokering occurs.

Another theoretical distinction that is relevant to this dissertation is related to when brokering occurs across the lifespan. The vast majority of language brokering research more broadly has focused on brokering that begins in childhood or early adolescence, when children are still acquiring their two languages and their family's social position within the host culture. Under the sociocultural framing, this timing matters because brokering that co-occurs with language acquisition may shape the representations being formed. Under the family systems framing, childhood brokering is theorized to disrupt the developing parent-child hierarchy, which is part of why it has been linked to parentification and effects on roles in the family. Brokering that begins in adulthood, for instance, among international students or adult immigrants who broker for family members after their own language systems are largely established, is likely to reflect a different process altogether. Rather than shaping acquisition or destabilizing a developing family hierarchy, adult brokering may be impacting already formed skills and roles at the linguistic, cognitive, and socioemotional levels. This distinction suggests that the brokering

experience is not a single construct that simply varies in amount, but one that may differ qualitatively depending on the developmental period in which it occurs. It is also important to note, that in the heritage bilingual population which serves as the focus of the present dissertation, majority were childhood brokers who continued brokering in adulthood, as opposed to individuals whose brokering onset began in adulthood; in this way, the populations discussed here had more stable brokering experience across the lifespan rather than disrupted brokering experience. This distinction is a guiding principle that the present dissertation returns to when considering both how to measure brokering and the generalizability of brokering effects across different populations.

The language brokering experience is heterogenous in nature; brokers must facilitate communication between members of their community and members of society, but they vary in their frequency of brokering and differ in whether this is a responsibility that only occurs in childhood or carries over into young adulthood. Language brokering is a complex process that requires skillful mastery of the two languages to convey meaning in a linguistic and culturally competent manner. Like code-switching, the ability of bilinguals to switch between their two languages to adapt to the needs of their interlocutors and to social cues (Woolford, 1983), brokering requires the fluent use of each language and the ability to switch between them (see López, 2015 for a comparison of language brokering and code-switching). Brokers are required to manage both linguistic and cultural information to serve as the communication intermediary between heritage language speakers and dominant language speakers. A prominent example of language brokering can be seen in the academy award winning film CODA which tells the story of a hearing girl who serves as the translator and interpreter for her deaf parents.

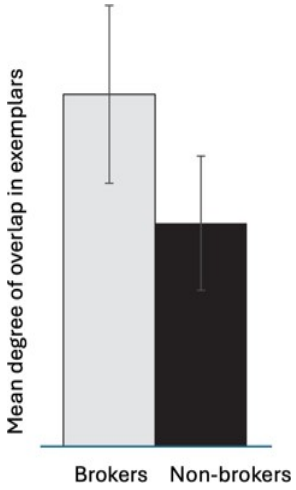
Most past research on language brokering has focused on its consequences for educational and social outcomes. Brokering has been linked to enhancements in grade point average (Acoach & Webb, 2004; Buriel et al., 1998), standardized test scores (Dorner, Orellana, & Li-Grining, 2007), and overall academic competence (Chen et al., 2020). Some studies suggest that these positive outcomes stem from the maintenance of the home language, which has been recognized as beneficial for cognitive and academic development (Bialystok & Craik, 2022; Bialystok & Poarch, 2014). However, other research indicates that the academic benefits of language brokering may be contingent upon whether bilinguals report positive emotional experiences associated with their role as brokers for their families (Kim et al., 2020).

It is only recently that efforts have been made to focus on the consequences of language brokering for language processing and to bring the brokering phenomenon into the laboratory. An essential feature of the experimental research on brokering is that most studies have treated language brokering experience as a categorical variable, clustering bilinguals as either "language brokers" or "non-language brokers." These studies have shown enhanced attention to ambiguity in discourse (Vaid et al., 2006), enhanced divergent thinking abilities (Vaid et al., 2015), and improved performance on executive function tasks (López et al., 2021) for language brokers.

Past studies have also assessed the ability of language brokers to identify correct translations of either literal of figurative translations of idiomatic phrases (López, 2015). Results revealed a benefit on figurative language processing, such that language brokers showed higher accuracy in correctly identifying idiomatic translations of phrases, particularly when the idiom was specific to Spanish (López, 2015). Brokering has also been associated with greater semantic overlap. López and Vaid (2018) found that Spanish-English brokers showed significantly greater overlap in exemplars generated across their two languages than non-brokers, both immediately

and after a week's delay, while both groups showed the expected pattern of more divergence across languages than within a single language (see Figure 1). They interpreted this as evidence that extensive brokering experience is associated with a more integrated conceptual representation of features shared across languages.

Figure 1. *Conceptual Overlap in Verbal Fluency Exemplars of Brokers vs. Non-Brokers*



Note. Adapted from López & Vaid, 2018. Degree of overlap in exemplars produced by brokers vs. non-brokers.

Given the nature of language brokering, these bilinguals must juggle information in both their L1 and L2 to successfully achieve communicative goals. To do so may incur consequences to language broker's language processing and cognitive functioning but those consequences have not been studied. In this dissertation, I take the variable of language brokering and treat it both categorically, as it has traditionally been treated, and more continuously, through a continuous individual differences approach. I also consider the consequences of brokering not for the state of language representation and proficiency which has been explored in past work, but for the

active language processing mechanisms that may be affected by experience translating and interpreting informally.

1.4 Language Brokering Versus Translation & Code-Switching

A key facet of language brokering is its informal nature, in contrast to formal translation and interpretation. Language brokering involves informal and spontaneous translation or interpretation performed by bilingual individuals within their social networks, often without specific training or qualifications (Wong et al., 2017). In contrast, formal translation refers to the professional practice of translating typically adhering to established standards and guidelines (Pöchhacker, 2016). While language brokering relies heavily on bilingual individuals' language skills and cultural knowledge, it may lack the precision and consistency expected in formal translation due to the absence of standardized procedures and quality control (Wong et al., 2017). Researchers have proposed that translation and interpretation are extreme forms of bilingual language control with a set of simultaneous tasks (e.g., listening, comprehension, self-monitoring, speech production) requiring skillful coordination of different brain systems (Hervais-Adelman & Babcock, 2020). Past studies have shown that serving as a translator and interpreter incurs enhanced working memory efficiency (Köpke & Nespoulous, 2006), improved speed and accuracy on psycholinguistic tasks (Christoffels et al., 2006), and increased attentional control (Timarová et al., 2014).

Trained interpreters are equipped with specialized linguistic and subject-matter expertise, enabling them to produce high quality translations. Critically, this expertise is often domain-specific. For example, medical interpreters receive training in clinical terminology and court interpreters in legal language and procedures (Pöchhacker, 2016). This domain expertise is a defining feature of professional translation because interpreters are selected and trained to

translate specialized content accurately. Language brokers, on the other hand, are often children who must adapt to achieve communicative goals between their family and society. Like interpretation, brokering shares the time pressure of translating in real time. There is also a potential effect of self-selection for adult bilinguals who seek formal training in simultaneous interpretation. Unlike adults, children have to perform the task of brokering out of necessity rather than by choice. All translators are bilingual, but not all bilinguals are necessarily translators.

Language brokering is also worth distinguishing from code-switching, another common bilingual practice with which it is sometimes conflated. Code-switching is largely opportunistic: bilinguals move between languages in response to social cues or interlocutor identity, and the choice to switch is typically up to their choice since the interlocutor is often bilingual as well and can accommodate either language (López, 2015; Woolford, 1983). Code-switching often takes place between peers whereas brokering in childhood involves translating for others who have a different status or social role than the broker (typically a power imbalance is present). Brokering also differs in that it is an obligatory role rather than self-selective and it is undertaken specifically because one party cannot access the other's language at all. Code-switching also does not necessarily require actively translating a concept from one lexical form into another, since production can simply shift languages without having to reconstruct the meaning across the two languages. In contrast, brokering always requires this active conceptual translation of extracting the meaning conveyed in one language and reconstructing it in the other for a listener in the other language. This distinction is relevant to the present dissertation, where code-switching frequency is considered as a related but separate construct from brokering experience.

1.5 Revised Hierarchical Model and Language Brokering

The ability to translate effectively and efficiently is a hallmark of the language brokering experience. Language brokers must receive input in one of their languages, translate it in their minds, and produce it in their other language. To do so, requires a great level of skill and seldom incurs mistakes. An account for this process is the Revised Hierarchical Model (RHM; Kroll & Stewart, 1994). The RHM proposed two lexical systems, one for each language (L1 and L2), in addition to an integrated and shared conceptual system. The model assumes that the L1 has direct access to the conceptual system, and that the strength of the connections between the L2 and the conceptual system varies according to level of proficiency. The model suggests that the connections between words in the L2 and its corresponding concepts are reinforced as proficiency in the L2 increases while lexical dependence on the L1 decreases. Therefore, proficient bilinguals may access the conceptual system directly from both their L1 and their L2, while second-language learners would access the system using the L1 only (see Kroll et al., 2010).

Translation is a complex production task that requires the ability to speak both languages at a relatively high level of proficiency. To investigate translation processes without the requirement to produce spoken language, many past studies have used the translation recognition task (de Groot, 1992). In this task, participants are asked to determine whether two words in each of their two languages are correct translation equivalents. In some studies, trials in which the two words are not translations, have been used to identify the information available. Talamas et al. (1999) included two distractor types: translation form distractors and semantic distractors. In the translation form condition, the second word resembles the lexical form of the translation but is not a correct translation (e.g., for the English word "ship," a Spanish distractor might be "banco"

meaning "bank" instead of "barco"). In the semantic condition, the second word is related in meaning to the correct translation (e.g., a Spanish semantic distractor for "man" might be "mujer" meaning "woman"). They found that learners at early stages of L2 learning were more likely to suffer interference from the form distractors while the more advanced learners were more sensitive to the semantic distractors, a result that supports the developmental trajectory proposed by the RHM (see Sunderman & Kroll, 2006).

Electroencephalography (EEG) studies have investigated the time course of processing translation pairs and helped to identify the critical event-related potential (ERP) components that differentiate learners at different stages (Ferré et al., 2023; Guo et al., 2012). Critically, behavioral and ERP measures have produced different accounts of the translation process, with brain activity more likely to identify the site of particular processes. For example, contrary to Talamas et al., Guo et al. (2012) showed that highly skilled bilinguals did show sensitivity to translation form distractors in behavioral measures of response time and accuracy. But the time course of processing revealed in the ERP analysis showed that access to meaning was available prior to the translation itself, suggesting that these skilled bilinguals were not using the L1 translation to access meaning. In this dissertation, I analyze both behavior and brain activity to identify the consequences of language brokering.

1.6 Dual Language Activation and Regulation

The RHM highlights the importance of the L1 in both stages acquisition and maintenance of the L2. The RHM initially assumed that the representations for words in the two languages were independent (Kroll & Stewart, 1994). But in the time since the model was proposed, we have learned that the bilingual's two languages are activated in parallel, with both languages available even when bilinguals intend to comprehend or speak one language alone (e.g.,

Blumenfeld & Marian, 2011; Dijkstra & Van Heuven, 2002; Giezen et al., 2015). The consequence of parallel activation is that bilingual speakers learn to regulate the two languages, drawing on domain-general cognitive resources to enable proficiency in each language without interference (Blanco-Elorrieta et al., 2016; Liu et al., 2014; Wang et al., 2022). Recent studies have shown that the adaptation that occurs is not only a matter of speaking two languages but also a reflection of the context in which the two languages are used and the environmental demands placed on the speaker (Green & Abutalebi, 2013). These studies show that the L1 that may be critically important in enabling bilinguals to avoid the interference that would result from dual language activation.

Language regulation is the process by which bilinguals manage dual language activation, enhancing activation of the intended language while reducing activation of the unintended language. Regulation has been studied through immersion in different language environments, revealing that bilinguals immersed in either their L1 or L2 develop a refined cognitive control mechanism to regulate their linguistic abilities and enable effective communication. For instance, Zhang et al. (2021) compared Mandarin-English bilinguals immersed in either their L2 or L1 environments, finding that those immersed in L2 contexts employed more proactive control strategies, whereas those in L1 contexts were less proactive. In language switching tasks, bilinguals immersed in L2 contexts exhibited greater inhibition of their L1 compared to those in L1 contexts, with a stronger association between cognitive control and language production. Similar results were reported by Beatty-Martínez et al. (2020) who examined the impact of language context on cognitive control for proficient Spanish-English bilinguals who varied in the way that the context enabled them to use the two languages. They found different patterns of picture naming performance as a function of whether the two languages were used separately or

interchangeably. Critically, for those immersed in the L2 with few opportunities to speak the L1, high levels of proactive control enabled the maintenance of the L1.

It is important to differentiate language regulation and cognitive control. Cognitive control is a domain-general mechanism that allows individuals to manage cognitive resources and adapt to shifting tasks, often highlighted in studies of bilinguals who are thought to draw on this mechanism to juggle two languages. However, a growing body of research suggests that cognitive control alone may not fully account for the complexities bilinguals face when using their two languages (van Assche et al., 2013). This work suggests that bilinguals draw on cognitive control in a more nuanced way, depending on the context in which they use their languages (Green & Abutalebi, 2013). While domain-general cognitive control is certainly engaged, bilinguals also engage language-specific regulation processes. These processes are not identical to cognitive control and are shaped by the communicative demands of the situation. For instance, a study by Zirnstein et al. (2018) demonstrated that bilinguals' initial lexical prediction was predicted by L2 proficiency, while the cost of encountering an unexpected word after a strong prediction depended on an interaction between L1 verbal fluency and inhibitory control through the AX-CPT. Bilinguals with stronger L1 regulation showed larger prediction-violation costs, but this effect attenuated with better inhibitory control. This work suggests that bilingual prediction processes draw on both language-specific regulation and domain-general cognitive control, indicating that language regulation involves processes that go beyond domain general cognitive control. Thus, bilinguals' ability to regulate their languages is not only dependent on domain-general control but also on specific linguistic processes that adapt to environmental and cognitive demands. Language regulatory processes and cognitive control work together to shape language processing outcomes.

I hypothesize that the cognitive demands of language brokering, such as managing dual language representations and ensuring accurate translation may enhance heritage bilingual's regulatory abilities. Brokering requires rapid language switching and adaptation to varying linguistic demands of the interlocutors, but also to the linguistic environment more broadly. Language brokering offers a unique lens to examine how a bilingual acquires and utilizes language regulation strategies. Language brokering may enhance bilinguals' ability to quickly and flexibly switch between languages, thereby strengthening their engagement of cognitive control mechanisms. This adaptive skill is hypothesized to enable language brokers to navigate complex linguistic environments efficiently and balance the demands of multiple languages while minimizing errors in communication. Brokering may lead to a range of consequences for language processing and for the mechanisms that support the engagement of cognitive resources to enable language regulation.

A recurring theme across research on bilingualism is that the developmental timing of a bilingual experience shapes its consequences as much as the experience itself does. Just as the neurocognitive consequences of early bilingual exposure differ from those of exposure that begins later in life (Johnson & Newport, 1989; Lenneberg, 1967), and just as plasticity for language learning appears to extend, in more limited and effortful form, well beyond early childhood (Pliatsikas, 2020; Steinhauer, 2014), the consequences of language brokering may depend on when brokering begins relative to the development of the language system. If brokering that begins in childhood becomes embedded in the developing lexical and conceptual representations, it should not be expected to leave the same imprint on language processing as brokering that happens in adulthood when those systems are already developed. That is not to

say that the external behavior may not look similar on the outside (i.e., matched performance on tasks), but the underlying mechanisms that support these processes may be tuned differentially.

Childhood and adulthood brokering are also likely to differ in who the broker is translating for and the contexts in which that translation occurs, further distinguishing the two experiences beyond their developmental timing alone. This distinction between childhood and adulthood brokering experiences, has been largely unaddressed in prior research that has treated brokering as a single categorical experience and it serves as a guiding thread across both studies reported in this dissertation. This last point is stated with the caveat that brokering may be a continuous experience, such that people brokered both in childhood and adulthood. The present analyses treat childhood and adulthood brokering as distinct periods; given how the language brokering questionnaire is structured, it would be possible to model the degree of overlap between them, and doing so is a direction for future analysis rather than a limitation of the measure itself.

1.7 Language Brokering and the Regulation It May Shape

Not every task places the same demand on language regulation, and brokering should not be expected to leave the same mark on all of them. Brokering itself is a specific kind of demand: a broker receives meaning in one language and must hold it active while reconstructing it in the other for someone who has no access to the source language at all. This is not simply selecting which language to speak but rather it is sustaining both languages at once at the level of meaning. If brokering shapes regulation, it should shape this part of it specifically, the coordination of two active languages around a shared meaning, rather than the more general ability to pick one language and suppress the other.

Verbal fluency and picture naming produced with words spoken when each language is produced independently, may not require the same regulation as a context in which both

languages are required to be actively used simultaneously. That is to say, the demands of language regulation are different depending on the task at hand, both at the experimental level and more generally. Naming in just one language (or in a pure block for the present study) requires the intentional suppression of the other language. Meanwhile, using both languages jointly (or naming in a mixed block in the present study) requires both languages to be in relatively equivalent levels of activation. Therefore, achieving different communicative goals incurs distinct demands of the language regulation mechanism. Translation recognition asks for something closer to what brokering itself requires: on every trial, a target must be evaluated against a distractor pulled from the other language, so the two languages are competing for the same resolution throughout.

Given this, I did not expect the consequences of brokering to appear uniform in just overall better performance on all tasks. If a task does not require intensive coordination between the two languages (i.e., pure blocks), then brokering should not incur significant gains. On the other hand, tasks that require the intensive coordination between both languages and the meaning of words in both languages (i.e., translation recognition, mixed picture naming blocks), the impact of brokering should be more evident.

I hypothesize that brokering refines something more specific than general language control. Instead, it affects the skillful, integrated use of two languages at the same time. This is not the same claim as saying brokering raises proficiency in either language because a broker does not need to be more fluent in Spanish or English to broker well, and I am not arguing that brokering experience should track with proficiency gains in either language alone. What brokering demands repeatedly is to hold both languages active together and coordinated, not simply becoming better at each one individually.

This also distinguishes brokering from code-switching, with which it might otherwise seem interchangeable. A person may be both a language broker and engage in code-switching, but this is not always the case necessarily; they may be related phenomena, but code-switching is a naturalistic bilingual practice whereas the translation role a broker undertakes is not. Both involve the frequent, rapid engagement of two languages, but code-switching is fundamentally an alternation. A bilingual moves from producing one language to producing the other, and even when that alternation happens quickly and often, only one language is being produced at any given moment. Brokering does not work this way. A broker holds a concept activated in one language while simultaneously producing it in the other, so the two languages are not taking turns but are engaged together, around the same piece of meaning, at the same time. Code-switching trains fast, clean movement between two separate modes. Brokering trains something closer to integration, sustaining both languages at once rather than alternating cleanly between them. If brokering sharpens language control, it should be this integrated, simultaneous form of control that is sharpened, not simply the speed or frequency with which a bilingual can move from one language to the other.

This also points to what, specifically, gets sharpened by that integration: the semantic link between the two languages. Translation at its core is the act of taking the meaning carried by words in one language and delivering that same meaning through different words in the other language. The words themselves (e.g., their sounds and forms) are not what a broker is responsible for preserving but the meaning is. Doing this repeatedly and doing it under the time pressure that brokering imposes should sharpen the connection between the two lexicons and the shared meaning they both draw on. If my line of thinking is in the right direction, then the consequences of brokering should be visible specifically where two languages compete over

shared meaning and should be absent where the competition is only about how words sound or look.

1.8 Roadmap

In this dissertation, I conducted two studies that explored the impact of language experiences and context on bilingual language processing and language regulation. This dissertation assessed the outcomes of language brokering and language context on language processing and the mechanisms that support the engagement of cognitive resources to enable language regulation. There is considerable interest in leveraging early life experiences to characterize and forecast later outcomes for young adulthood. Despite their widespread presence, heritage speakers who serve as language brokers have been notably underrepresented in past research. There remains a gap in understanding the effects of language brokering experiences on language processing itself.

In Study 1, I took an interactional context approach, examining how the experience of language brokering shapes language processing and regulation across three groups of bilinguals: Spanish-English heritage bilinguals and Mandarin-English heritage bilinguals, both based in Southern California, and Spanish-English sequential bilinguals in Mexico. This behavioral study allowed me to ask whether the consequences of brokering generalize across different language pairs and to explicitly compare brokers to non-brokers within the same language pair.

In Study 2, I investigated how the brain processes word-level meaning during a translation recognition task, using ERP measurements to capture the time course of word-pair processing in Spanish-English language brokers based in Southern California. To my knowledge, this is one of the first studies to assess the experiences of language brokers using EEG techniques. The novelty of using ERPs with a population of language brokers lies in the

technique's functionality: it makes it possible to uncover the neural underpinnings that support translation processes. In some cases, the brain may reveal what behavior alone does not.

The structure of this dissertation is as follows. Chapter 1 situates language brokering within the broader literature on bilingual language experience, dual language activation, and language regulation, and closes with the predictions tested across both studies. Chapter 2 presents Study 1, a cross-context and cross-cultural behavioral investigation comparing Spanish-English heritage bilinguals, Mandarin-English heritage bilinguals, and Spanish-English sequential bilinguals in Mexico on verbal fluency, picture naming, and translation recognition performance, with a focus on how language brokering and interactional context jointly shape language dominance and lexical access. Chapter 3 presents Study 2, which extends this work by adding ERP measures to the translation recognition task among Spanish-English brokers in Southern California, allowing me to ask whether brokering experience is reflected in the neural time course of lexical and semantic access, beyond what behavior alone can show. Chapter 4 synthesizes the findings of both studies, considers their combined theoretical and practical significance, and outlines the limitations and future directions raised by this work.

Chapter 2: Study 1 — Interactional Context and Language Brokering

2.1 Introduction

It is crucial to examine how the context in which two languages are used supports different cognitive control strategies as a result of distinct language regulation demands. Language regulation is the process by which bilinguals manage dual language activation, enhancing activation of the intended language while reducing activation of the unintended language. Regulation has been studied through immersion in different language environments, revealing that bilinguals immersed in either their L1 or L2 develop cognitive control mechanisms

to regulate their linguistic abilities (Zhang et al., 2021). Other studies which examined the impact of language context on cognitive control for proficient bilinguals of the same two languages found different patterns of picture naming performance as a function of whether the two languages were used separately or interchangeably (Beatty-Martínez et al, 2020). Research focused on bilingual language context has brought forth the importance of conducting cross-cultural research.

Using a behavioral task battery, I assessed the experiences of bilinguals in Southern California and Mexico through a cross-cultural and cross-linguistic lens to understand how distinct bilingual contexts and language pairings impose differential demands on language processing and regulation. Perhaps most important to this dissertation is that I am examining three groups of bilinguals, each with a different set of demands imposed by the environment: Spanish-English heritage bilinguals in Southern California and Mandarin-English heritage bilinguals in Southern California who have language brokering experience, and Spanish-English sequential bilinguals in Mexico who do not. Including both Spanish-English and Mandarin-English brokers allows me to ask whether the consequences of brokering are specific to a particular language pair or instead reflect a more general signature of the brokering experience itself, one that should emerge regardless of which two languages a broker manages. I hypothesize that the cognitive demands of language brokering, such as managing dual language representations and ensuring accurate translation, enhance heritage bilinguals' regulatory abilities regardless of the specific languages involved. Brokering requires rapid language switching and adaptation to varying linguistic demands of the interlocutors, but also to the linguistic environment more broadly. Therefore, language brokering may enhance bilinguals' ability to quickly and flexibly switch between languages, thereby strengthening their engagement

of the cognitive resources that support language regulation. This adaptive skill is hypothesized to enable language brokers to navigate complex linguistic environments efficiently, balancing the demands of multiple languages while minimizing errors in communication. Brokering may lead to a range of consequences for language processing, affecting proficiency in addition to the mechanisms that support the engagement of cognitive resources to enable language regulation, which are evidenced by distinct language processing profiles for brokers in Southern California relative to non-brokers in Mexico, and by comparing the two broker groups to each other.

Moreover, conducting cross-cultural work is crucial for the study of brokering given the characteristics of brokering communities. Language brokering is a particularly distinct characteristic in bilingual communities marked by immigration (Weisskirch, 2017). Given the context in Southern California, particularly its proximity to the U.S.-Mexico border (Mora et al., 2005), there is a large population of immigrants who rely on children to serve as brokers. As a result, nearly all heritage bilinguals in Southern California report having acted as language brokers during their childhood, and many continue to serve in this capacity into adulthood in various ways. While the specific patterns of language brokering may vary between individuals, the experience itself is widespread. Studying a population of sequential Spanish-English bilinguals in Mexico, who were not administered the brokering questionnaire and for whom extensive childhood brokering is unlikely given their linguistic environment, helps to distinguish the unique roles and contributions of language brokering to language processing and cognition in real time.

Including a Mandarin-English broker group alongside the Spanish-English comparison also allowed this study to speak to a question that a single language pair cannot address on its own: whether any consequences of brokering are uniform across language pairs or instead interact

with the structural relationship between a bilingual's two languages. Spanish and English share substantial cognate vocabulary and overlapping orthography, a similarity that, under the RHM's account of shared lexical-conceptual links (Kroll & Stewart, 1994), should increase competitor activation during translation and lexical access tasks relative to a more typologically distant pair such as Mandarin and English, where script, phonology, and morphology differ substantially from English. If language brokering operates as a general enhancement of cross-language regulation, its behavioral signature should be broadly similar across the two broker groups despite this typological difference. If instead cross-language similarity itself shapes how brokering-related demands are met, the two broker groups may diverge from each other in ways that are better explained by language-pair typology than by brokering status alone. Distinguishing between these two possibilities is only possible by comparing brokers of two structurally different language pairs directly, which is the central rationale for Study 1's three-group design.

Given how ubiquitous the language brokering experience is, here I took the approach of exploring this experience in two different ways. The first approach is centering this research on the heritage bilingual experience of language brokers itself. I aim to examine the wide spectrum of language brokering experiences to better understand how brokering may occur at varying degrees and move beyond the typical categorical approach of understanding brokering. Through this approach, I aim to understand how language brokering and which aspects of it are crucial in terms of changing how bilinguals process language more generally and what they know. The second approach goes back to more typical routes of studying bilingualism by focusing on the categorical distinction between brokers and non-brokers. However, here I examine the demands of respective contexts and how these serve to alter language processing and cognition.

2.2 Research Sites and Participants

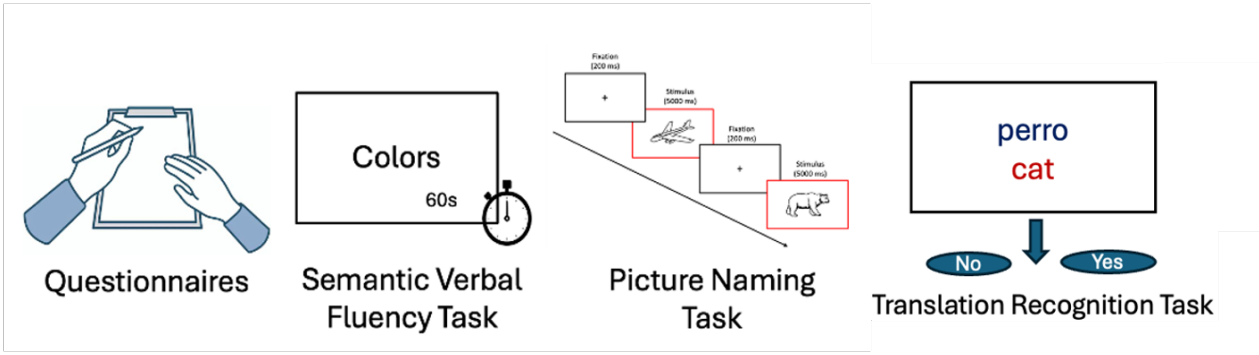
Study 1 recruited three groups of participants: heritage Spanish-English language brokers and heritage Mandarin-English language brokers, both recruited from Southern California (with testing at the University of California, Irvine), and Spanish-English bilinguals recruited from the Universidad Autónoma del Estado de Morelos (UAEM) in Mexico who have not served as language brokers. This group was not administered the language brokering questionnaire, so brokering status could not be directly assessed for these participants; however, given what is known about this population's linguistic environment, extensive childhood language brokering is unlikely. Participants completed a single behavioral session administering the shared task battery described below.

The group of Spanish-English bilinguals in Mexico were native Spanish speakers who learn English at a later age. They go to school in Spanish, interact with family and friends in Spanish, but English plays a role for them in professional life. On average, most of this population takes English classes starting in grade school with varying proficiency, but start to hone in on this language skill later in life when it becomes more relevant in professional settings. English becomes the language of currency for them, so many people take classes all the way to the college level (where in many circumstances they are also taking classes where they have to reference materials in English). From a personal observation upon my time at the lab in Cuernavaca, the lab discussions were often in Spanish, but they were unpacking research papers in English. Therefore, despite deeper connection to Spanish because of it being the majority language of the country and people of close proximity including family and friends, many had incentives and motivation to learn English.

On the other hand, the heritage bilingual populations in Irvine, California had very different experiences. These are bilinguals who have a heritage language (either Spanish or Mandarin) to which they have a cultural connection and often learn and use this language in the home setting during the earliest stages of life. However, most of this population begins to acquire the dominant societal language, English, upon entry into the school system, typically around age five. They therefore have proficiency in both languages from an early age, but at some point, many begin to experience a common phenomenon known as a language dominance shift, in which the societal language becomes dominant. However, this dominance shift is not universal: some heritage bilinguals retain dominance in the L1 heritage language for a variety of reasons. Depending on the cultural group and specific social context, individuals may play different roles in their social networks that shape how they maintain and use their two languages. For example, code-switching practices, attitudes toward this practice, and overall experience may not be uniform across groups. Of central focus to this dissertation are the other language experiences, like language brokering, in which individuals take on the role of translator for their families and communities.

Comparing the two Southern California broker groups to each other tests whether the consequences of brokering are general to the brokering experience itself rather than specific to Spanish-English bilingualism, while comparing the Spanish-English brokers to the Spanish-English non-brokers in Mexico isolates the specific contribution of brokering, holding the language pair constant.

Figure 2. *Experimental task battery for Study 1*



2.3 Task Battery

Study 1 includes a behavioral task battery (see Figure 2) administered across three groups and two research sites: the University of California, Irvine, and the Universidad Autónoma del Estado de Morelos.

Questionnaires utilized in the present task battery were created and hosted in the Gorilla Experiment Builder platform (Anwyl-Irvine, 2020). For the behavioral tasks of these studies, participants' performance data (accuracy and reaction time) were recorded on E-Prime 3.0 software, a software package for designing and running psychological experiments (Psychology Software Tools, 2016).

Both studies share a common task battery consisting of a language experiences questionnaire (the Bilingual Language Profile), a verbal fluency task, a picture naming task, a social network questionnaire, and the Translation Recognition Task. Where groups can be reasonably matched on the frequency, period across the lifespan, and continuity of their brokering experience, participants also completed the language brokering questionnaire described below; otherwise, this measure is treated as exploratory. Both studies capture data on language regulation and lexical access.

2.3.1 Language Experiences Questionnaires

Participants completed two questionnaires to capture their language experiences. I administer the Bilingual Language Profile (BLP; Birdsong et al., 2012) which is a self-report of bilingual language dominance. The BLP produces a score of dominance which is crucial for the experiences of heritage bilinguals whose language dominance often shifts across the lifespan.

Participants who were heritage bilinguals subsequently completed a questionnaire on the range of their language brokering experiences. The questionnaire was designed by compiling items from previous studies on language brokering (Kim, Hou, & Gonzalez, 2017; López, 2015) and adding items intended to capture the frequency and continuity of brokering more comprehensively across the lifespan. The questionnaire can be found in the appendix of the present dissertation. Rather than treating brokering as a single undifferentiated experience, the questionnaire was designed to capture several dimensions theorized to be relevant to how brokering shapes language use and cognition: who the participant brokered for (e.g., parents, other relatives), the frequency with which brokering occurred, the contexts in which it occurred (e.g., medical, educational, or bureaucratic settings), the modality of the brokering task (spoken versus written translation), family structural position (sibling order, given that older siblings are often positioned as default brokers), and, critically, the developmental continuity of the experience as in whether brokering was confined to childhood or persisted into adulthood, a feature that, to our knowledge, no previous language brokering research has captured. This more granular approach allows the present questionnaire not only to support binary group comparisons between brokers and non-brokers, as in prior work, but also to examine variation within the brokering population itself, a level of detail that has not been a central focus of previous

research. It is of note that this more extensive questionnaire is exploratory in nature but may generate insights that inform future measurement of brokering experience.

It is important to note that this questionnaire was not administered to the sequential bilinguals recruited in Mexico, because brokering is not a central feature of their language ecology. As conceptualized in the literature, language brokering is fundamentally tied to the immigrant family context, in which bilingual children translate for parents or relatives with limited proficiency in the host society's dominant language (Morales & Hanson, 2005; Orellana, 2009). Because this sample was recruited in Mexico, where Spanish is both the participants' and their families' societal language, the structural conditions that give rise to brokering in immigrant and first-generation populations do not apply in the same way. This is not to say that sequential bilinguals in Mexico never serve as translators between Spanish and English, but any such translation task undertaken later in life is fundamentally distinct from brokering that begins early in development. Administering the brokering questionnaire to this group would therefore have risked conflating the absence of an applicable brokering role with the absence of brokering experience.

2.3.2 Social Network Questionnaire

Both studies also included a social network questionnaire, which aims to assess participants' social interactions and linguistic practices. Bilingual participants provide details about their personal social networks using Network Canvas (Janulis et al., 2023). Participants are asked to identify 15 people they regularly interact with in their daily lives. For each person, they answer a series of questions about how often they communicate and the emotional closeness they share, which helps assess the strength of their relationship. They also indicate the social contexts (e.g., family, work, school) and communication methods (e.g., in person, instant messaging) they

use when engaging with each individual. Additionally, participants note which language(s) they typically use when interacting with each person. This questionnaire provides insights into participants' language use in social contexts, offering data on how language proficiency and social integration may influence translation processing. Through use of social network science, I hope to gain a deeper understanding of the social factors, beyond language brokering itself, that contribute to bilingual individuals' translation abilities.

2.3.3 Verbal Fluency Task

Participants completed a measure of verbal fluency. In this task, participants are given a block of categories in Spanish, and English, respectively with the order of presentation counterbalanced. Eight semantic categories (four in each language) are with counterbalancing occurring across participants. Participants have 30 seconds to list as many exemplars per category in the indicated language.

2.3.4 Picture Naming Task

Language production abilities were assessed with a picture naming task. In this task, participants name a total of 160 black and white drawings in Spanish and English, respectively. The pictures for this task have been picked from an online normed database, the International Picture Naming Project (Szekely et al., 2004) and these are matched in terms of visual complexity, frequency, and semantic category. The procedure for this task includes two pure language blocks and one mixed language blocks. Participants name 40 pictures in the pure Spanish block, 40 pictures in the pure English block, and switch between naming 40 pictures in Spanish and 40 pictures in English in the mixed language block. This picture-naming task was part of a larger combined project with distinct research goals across studies; for the other study in

that project, the mixed block was designed around an emotion-word paradigm. Because of this design difference, the mixed-block data are not directly comparable across studies and are therefore not reported in Study 1.

They are instructed to name pictures in each of their two languages based on the color of the picture frame (red or blue) which is counterbalanced across participants. The order of the homogenous language blocks is randomly counterbalanced, such that half of the participants name in pictures in a pure Spanish block first and the other half names pictures in a pure English block first. In the heterogenous language-switching block, participants do not have to name pictures in a single language for more than three consecutive trials to ensure sufficient language-switching. As documented by previous work (Meuter and Allport, 1999) the order of language blocks may impact the accuracy and reaction time of naming, a phenomenon that has been widely cited as an example of inducing short-term language regulation in the laboratory setting (Misra et al., 2012).

2.3.5 Translation Recognition Task

The main experimental task for Study 1 is the Translation Recognition Task, administered behaviorally so that it can be used at both research sites. Participants were presented with word pairs, one word in each of their two languages, and must determine whether the pair is a correct translation. The task includes 200 translation pairs, following the distribution used in previous studies (Talamas et al., 1999; Sunderman & Kroll, 2006): 25% correct translations, 25% incorrect translations unrelated to each other (unrelated control), 25% incorrect translations based on lexical form distractors, and 25% incorrect translations based on semantic form distractors. For the Mandarin-English broker group, translation pairs are adapted and normed in Mandarin and English following comparable criteria for lexical and semantic

relatedness, since the original stimulus set was developed for Spanish-English translation equivalents.

2.4 Data Cleaning and Analysis

Verbal Fluency: Accuracy on the verbal fluency task was calculated separately for each language. Responses are coded as accurate if the participant produces a valid word within the semantic category. Responses that do not belong to the target category are coded as inaccurate. Since this is a free recall verbal fluency task, there is no reaction time recorded, instead they must list as many words as they can within a 30 second time frame.

Picture Naming: Accuracy on the picture naming task is calculated separately for each language. Responses are coded as accurate if they produce the target word, a mispronunciation of the target that is still intelligible, or an appropriate alternative name for a picture. Omissions, responses that are not appropriate names for the target picture, and responses such as "I don't know" are coded as inaccurate. Reaction time data only include correct responses to target pictures. Absolute outliers are classified as those with response times of less than 300 milliseconds and those more than 3000 milliseconds; absolute outliers were removed from our data frame. Subsequently, all reactions times greater than 2.5 standard deviations above or below each participant's mean per each language are eliminated.

Translation Recognition Task: Responses were considered correct if the participant correctly identified the translated word as matching or not matching the presented stimulus word. Reaction times are only considered for valid correct responses. Absolute outliers, with response times below 200 milliseconds or above 2000 milliseconds, are removed from the dataset. Additionally, any reaction time outside of 2.5 standard deviations above or below each participant's mean is excluded from analysis.

Behavioral data are analyzed using mixed-effects models with the lme4 software package (Bates et al., 2015) within the R programming environment (R Development Core Team, 2014). Data for participants who drop out of the study or whose task battery is incomplete are excluded from distinct sub-analyses.

A general analytical approach was used for data from the different task battery. All reaction time and accuracy data were analyzed using linear or generalized linear mixed-effects models in R (R Core Team), implemented via the lme4 package (Bates et al., 2015). For each analysis, a baseline model was first constructed, and predictors of theoretical interest were added incrementally to evaluate whether they improved model fit. Model comparison relied on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), with lower values indicating a better balance between fit. The model with the best fit was retained for interpretation. In some cases, a specific a priori model structure was used based on the theoretical motivation for the analysis, without a formal model comparison step. The models included a random intercept for participant to account for repeated measures. Significant interactions were followed up with pairwise comparisons of estimated marginal means using the emmeans package (Lenth, 2023).

2.5 Predictions

Self-reports: I predict that heritage bilinguals in Southern California, of both Spanish-English and Mandarin-English language pairs, will self-report that English (L2) is more dominant than their heritage L1, consistent with the dominance shift typically observed in heritage bilinguals raised in the United States. In contrast, I predict that Spanish-English sequential bilinguals in Mexico will self-report greater Spanish (L1) dominance than either broker group in California. Between the two Southern California groups, I do not expect

language brokering to eliminate the overall dominance shift toward English, but I predict that more habitual brokers (on the continuum of brokering) in both language pairs will report more frequent use of their heritage language in daily life than would be typical of non-broker heritage bilinguals, reflecting the maintenance function that brokering appears to serve regardless of the specific heritage language involved.

Production: I predict that performance on the language production tasks, particularly verbal fluency and picture naming, will align with bilinguals' self-reports. Bilinguals in Mexico are expected to show strong Spanish dominance, while both broker groups in California are expected to show stronger English dominance overall, but with better heritage-language maintenance (higher accuracy, faster reaction time, and more heritage-language exemplars) than would be expected of non-broker heritage bilinguals in a comparable U.S. context (not tested here). Because Zhang and colleagues (2021) found that Mandarin-English bilinguals immersed in an L2-dominant environment rely heavily on proactive language control, I predict that Mandarin-English brokers show a pattern of heritage-language maintenance broadly similar to that of Spanish-English brokers, despite the substantial differences between Mandarin and Spanish in orthography and structural distance from English. If Mandarin-English brokers show a different pattern than Spanish-English brokers, this would suggest that the specific demands of a language pair shape how brokering affects language regulation. This would point to a language-pair-specific effect rather than brokering alone operating as a language-general experience.

Social Networks: I predict that social network dynamics will reveal notable differences across the three groups. Both broker groups in California, given their roles facilitating communication across cultural and linguistic boundaries, are expected to show more diverse and

dispersed social networks in terms of language use than the non-broker group in Mexico. I expect this pattern to hold similarly for Spanish-English and Mandarin-English brokers, since it reflects the interactional demands of brokering itself rather than the specific heritage language involved. In contrast, I predict that bilinguals in Mexico show a more tightly knit network, with a stronger emphasis on family and local community relationships. For the heritage groups specifically, I also predict differences in reporting of code-switching practices, such that the Spanish-English group will report more switching tendencies in line with previous research.

Translation Recognition: I first compare all three groups to test whether the Southern California heritage bilingual groups outperform the Mexico sequential bilingual group, showing higher accuracy and faster reaction times overall. This comparison establishes whether interactional context, rather than brokering per se, structures performance recognition of translation pairs. I then restrict analysis to the two broker groups in Southern California and treat brokering as a continuous variable. This approach avoids the confound of comparing brokers to non-brokers and instead asks whether the degree of brokering experience predicts performance within a population that all broker to some extent. I predict that brokering frequency will be associated with improved resolution (in accuracy and reaction time) of semantic distractors, as more frequent brokering may rely more heavily on semantic processing to access translation equivalents. I also predict that brokering frequency will be associated with a superior ability to reject distractors that are similar in form to the target translation, reflecting enhanced lexical access in both languages.

Comparing the heritage broker groups to one another allows me to ask whether these continuous brokering effects are specific to Spanish-English bilingualism or reflect a more general consequence of brokering. If brokering confers a general advantage regardless of

language pair, I expect the relationship between brokering frequency and semantic distractor interference, as well as the relationship between brokering frequency and form-related distractor rejection, to hold similarly in both heritage groups.

2.6 Results

Results for Study 1 are organized by task. I begin the results section by characterizing the three participant groups with regards to demographics and language experiences as self-reported in the Bilingual Language Profile, language brokering and social network questionnaires. I first report verbal fluency performance, followed by picture naming reaction time and accuracy, and finally the translation recognition task, where I also test whether reaction time varies as a function of childhood versus adulthood language brokering experience.

2.6.1 Participant Characteristics

Table 1 summarizes the demographic composition of the three Study 1 groups. The sample skewed slightly towards more female participants across all three groups (62–67%), and the two Southern California groups were closely matched in age, averaging around 20 years old, while the sequential bilinguals in Mexico were somewhat older on average, in their mid-twenties.

Table 1. *Study 1 Participant Characteristics*

	Spanish-English sequential bilinguals in Mexico	Spanish-English heritage bilinguals in the U.S.	Mandarin-English heritage bilinguals in the U.S.
Age (yrs), *M (SD)*	24.06 (6.43)	20.13 (2.43)	19.66 (1.23)
Female, *n(%)*	21 (62%)	20 (67%)	18 (62%)
Male, *n(%)*	13 (38%)	10 (33%)	11 (38%)

Table 2. *Study 1 Background Language Profile by Group*

	SE-SB (Mexico)	SE-HB (U.S)	ME-HB (U.S)
English			
Age of Acquisition, M (SD)	8.74 (4.50)	3.03 (2.43)	4.86 (4.04)
Speaking, M (SD)	4.50 (0.99)	5.80 (0.41)	5.10 (0.86)
Reading, M (SD)	4.74 (1.36)	5.93 (0.25)	5.17 (0.93)
Writing, M (SD)	4.03 (1.29)	5.83 (0.38)	5.03 (1.02)
Understanding, M (SD)	5.03 (0.76)	5.93 (0.25)	5.28 (0.88)
Other language			
Age of Acquisition, M (SD)	0.50 (1.85)	0.77 (2.61)	0.17 (0.93)
Speaking, M (SD)	5.79 (0.48)	4.57 (0.97)	5.14 (1.9)
Reading, M (SD)	5.56 (1.24)	4.93 (0.84)	4.86 (1.57)
Writing, M (SD)	5.56 (0.56)	4.07 (1.28)	3.66 (1.95)
Understanding, M (SD)	5.88 (0.33)	5.27 (0.89)	5.41 (0.82)

Note. SE-SB = Spanish-English sequential bilinguals in Mexico; SE-HB = Spanish-English heritage bilinguals in the United States; ME-HB = Mandarin-English heritage bilinguals in the United States. "Other language" refers to Spanish for the SE-SB and SE-HB groups and Mandarin for the ME-HB group. Participants rated their abilities on a scale from 0-6.

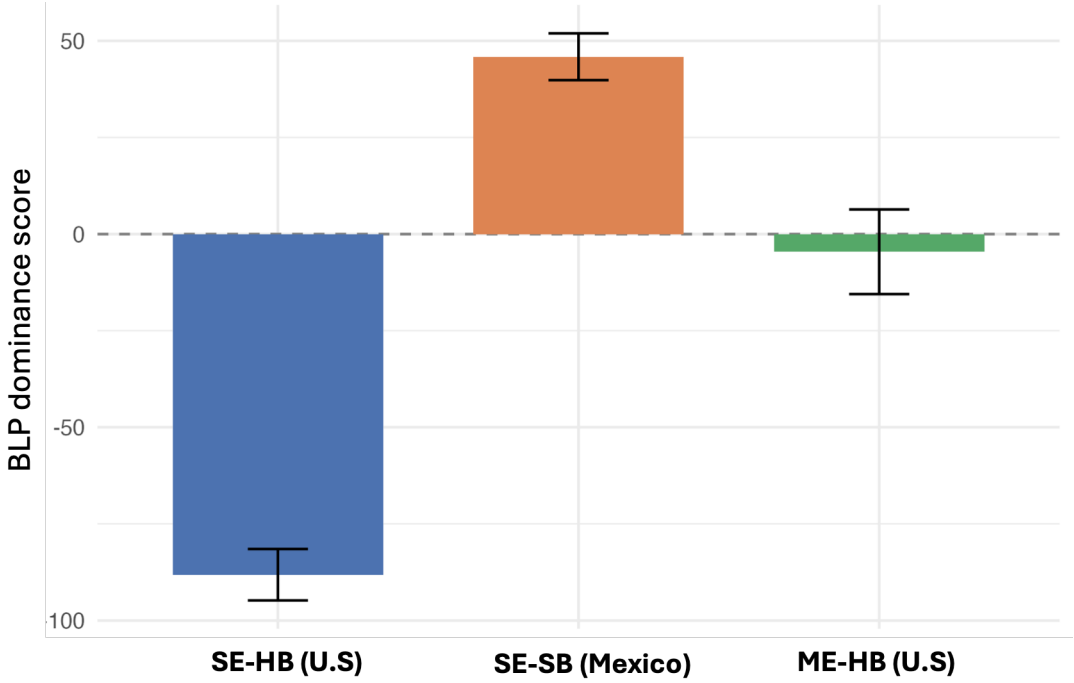
The three groups also tell three distinct stories about what it means to be bilingual, and the Background Language Profile (Table 2) puts numbers to those stories. The sequential bilinguals in Mexico grew up immersed in Spanish and only came to English later, presumably through formal schooling, and their self-reported profile reflects that trajectory with consistently higher proficiency in Spanish across speaking, reading, writing, and understanding. This population reflects a Spanish-dominant bilingual for whom English is a acquired tool rather than a home language.

The Spanish-English heritage bilinguals in California essentially show the opposite image. They acquired English earliest of the three groups and report the strongest English proficiency across every skill domain. Meanwhile their Spanish is the weakest other-language profile of the three groups, particularly for speaking and writing. This is the classic heritage-bilingual dominance shift: a language that was the home language in early childhood gradually

reduces as English, the language of school and the broader society, takes over as the stronger and more comfortable language.

The Mandarin-English heritage bilinguals occupy a middle position between these other two profiles in an interesting way. Their English proficiency looks like that of the Spanish-English heritage bilinguals, where it is early-acquired, but their heritage language, Mandarin, appears to be holding on more successfully than Spanish does for the other heritage group in speaking and understanding ability. Their Mandarin proficiency for speaking and understanding, while not drastically different from the Spanish-English heritage bilinguals' Spanish, is higher on

Figure 3. *Language Dominance by Group*



Note. Dominance scores were calculated from the Bilingual Language Profile (BLP) and reflect relative language dominance. On the y-axis, positive values indicate greater English dominance, whereas negative values indicate greater dominance in the other language (Spanish for the Spanish-English groups; Mandarin for the Mandarin-English group). Error bars represent ±1 standard error of the mean (SE). SE-SB = Spanish-English sequential bilinguals in Mexico; SE-HB = Spanish-English heritage bilinguals in the United States; ME-HB = Mandarin-English heritage bilinguals in the United States.

paper, while their reading and writing ability in Mandarin is lower than for their Spanish-English counterparts. It is important to note that given the different script and orthography, possessing less reading and writing ability in Mandarin is a common characteristic associated with this heritage bilingual group (Gatti O'Neill,, 2018; Montrul, 2016). In other words, this group appears to be managing their heritage language differently than Spanish-English heritage bilinguals: while some domains of language are English dominant, others maintain heritage language dominance. This observation becomes important in the results that follow. In summary (Figure 3), the sequential bilinguals in Mexico are Spanish-dominant, the Spanish-English heritage bilinguals are English dominant, and the Mandarin-English heritage bilinguals are somewhere in between.

The brokering-specific data (Table 3) add a further layer to this story for the two broker groups. On most dimensions (how many people they brokered for, how much of their brokering happened through speech, and how they feel about the experience) the Spanish-English and Mandarin-English brokers look quite similar, both in childhood and adulthood. Where they differ is in the intensity of their childhood brokering specifically, as the Spanish-English brokers report doing more text-based translation, brokering more frequently, and accumulating higher total brokering scores overall than the Mandarin-English brokers do, even though the two groups' adulthood brokering and attitudes toward brokering do not differ much. Both groups also describe a similar trajectory over time with somewhat less brokering activity in adulthood than in childhood.

Table 3. *Study 1 Language Brokering Characteristics*

	SE-HB (U.S.)	**ME-HB (U.S.)**
People brokered for		
Childhood	15.48 (4.25)	14.21 (5.90)
Adulthood	14.33 (5.04)	13.75 (7.27)
Speech brokering		
Childhood	24.44 (8.72)	21.26 (6.75)
Adulthood	20.71 (10.34)	18.65 (9.66)
Text brokering		
Childhood	25.32 (9.59)	19.63 (6.25)
Adulthood	20.43 (11.04)	17.40 (7.84)
Brokering frequency		
Childhood	65.24 (21.04)	55.11 (13.25)
Adulthood	55.48 (24.95)	49.80 (18.88)
Attitudes toward brokering		
Childhood	77.64 (10.89)	72.58 (13.01)
Adulthood	80.57 (14.06)	75.90 (15.24)
Total language brokering		
Childhood	142.88 (26.09)	127.68 (19.17)
Adulthood	136.05 (34.45)	125.70 (22.64)
Overall	280 (59.14)	253.50 (41.23)

Note. Language brokering dimensions reflect (a) people brokered for (7 items, range 0–35); (b) speech brokering (10 items, range 0–50); (c) text brokering (10 items, range 0–50); (d) brokering frequency, or how often participants engaged in language brokering, derived from the people, speech, and text dimensions; and (e) attitudes toward language brokering (23 items, range 23–115).

These three groups cannot be reduced to just their experiencing brokering or their proficiencies. They represent three different ecologies of bilingual language usage: a Spanish-dominant sequential bilingual shaped by professional and academic English, an English-dominant heritage bilingual with support for both languages whose Spanish is visibly reducing and an English-dominant heritage bilingual whose Mandarin appears comparatively resilient. For the heritage groups, there is an added layer on top of a shared brokering role. That combination of dominance profiles and brokering intensity is the backdrop against which the production and translation-recognition findings in this chapter should be considered.

Social Networks

Table 4 presents descriptive statistics for the Social Network questionnaire. It shows code-switching tendencies, emotional closeness with people in their networks, contact frequency,

Table 4. *Social Network Descriptives*

Metric	Spanish-English sequential bilinguals in Mexico *M (SD)*	Spanish-English heritage bilinguals in the U.S. *M (SD)*	Mandarin-English heritage bilinguals in the U.S. *M (SD)*
Code-switching frequency	0.52 (0.46)	1.10 (0.66)	0.78 (0.46)
% alters with whom they code-switch	29.33 (17.42)	53.10 (26.09)	40.00 (22.04)
Closeness	3.41 (0.50)	3.53 (0.65)	3.43 (0.54)
Contact frequency	3.07 (0.50)	3.14 (0.31)	2.85 (0.42)
Network density	0.18 (0.09)	0.15 (0.06)	0.13 (0.08)

Note. Network size was fixed at 15 alters per participant across all groups by protocol design. Code-switching frequency, closeness, and contact frequency were rated on 0–6 scales; % alters with whom participants code-switch is a percentage (0–100); network density is a proportion of observed to possible ties within each participant's fixed 15-alter network (0–1).

and network density across the three groups: Spanish-English sequential bilinguals in Mexico (n = 15; data loss), Spanish-English heritage bilinguals in the U.S. (n = 29), and Mandarin-English heritage bilinguals in the U.S. (n = 29). Due to survey data loss, the Social Network questionnaire has substantially more missing data in the Mexico sample than the fluency and naming tasks; all social network analyses below reflect n = 15 for this group.

Code-Switching Frequencies

Groups differed significantly in mean code-switching frequency, $H(2, N = 73) = 10.50$, $p = .005$, $\varepsilon^2 = .12$. Pairwise comparisons (Mann-Whitney U tests, Bonferroni-adjusted) indicated that Spanish-English heritage bilinguals in the US reported significantly more code-switching than Spanish-English sequential bilinguals in Mexico, $U = 95.0$, $z = -3.04$, $p_{adj} = .007$, $r = .46$.

The Mandarin-English heritage group did not differ significantly from either Spanish-English group (vs. Mexico: $U = 138.0$, $z = -1.98$, $p_{adj} = .142$, $r = .30$; vs. US Spanish-English: $U = 306.0$, $z = -1.77$, $p_{adj} = .228$, $r = .23$), though its mean fell numerically between the other two groups.

Proportion of Alters With Any Code-Switching

The same pattern held for the proportion of alters with whom any code-switching occurred, $H(2, N = 73) = 9.72$, $p = .008$, $\varepsilon^2 = .11$. Spanish-English heritage bilinguals in the US code-switched with a significantly larger proportion of their network than Spanish-English sequential bilinguals in Mexico, $U = 99.0$, $z = -2.95$, $p_{adj} = .010$, $r = .44$. The contrast between the two heritage groups did not survive Bonferroni correction ($U = 290.0$, $z = -2.03$, $p_{adj} = .127$, $r = .27$), nor did the Mexico–Mandarin heritage contrast ($U = 162.0$, $z = -1.39$, $p_{adj} = .496$, $r = .21$).

Contact Frequency

Groups also differed in contact frequency, $H(2, N = 73) = 7.08$, $p = .029$, $\varepsilon^2 = .07$. Here the significant pairwise contrast was between the two US heritage groups: Spanish-English heritage bilinguals reported more frequent contact with their networks than Mandarin-English heritage bilinguals, $U = 251.0$, $z = -2.64$, $p_{adj} = .025$, $r = .35$. Neither heritage group differed significantly from the Mexico sequential group on this measure (both $p_{adj} = 1.00$).

Closeness

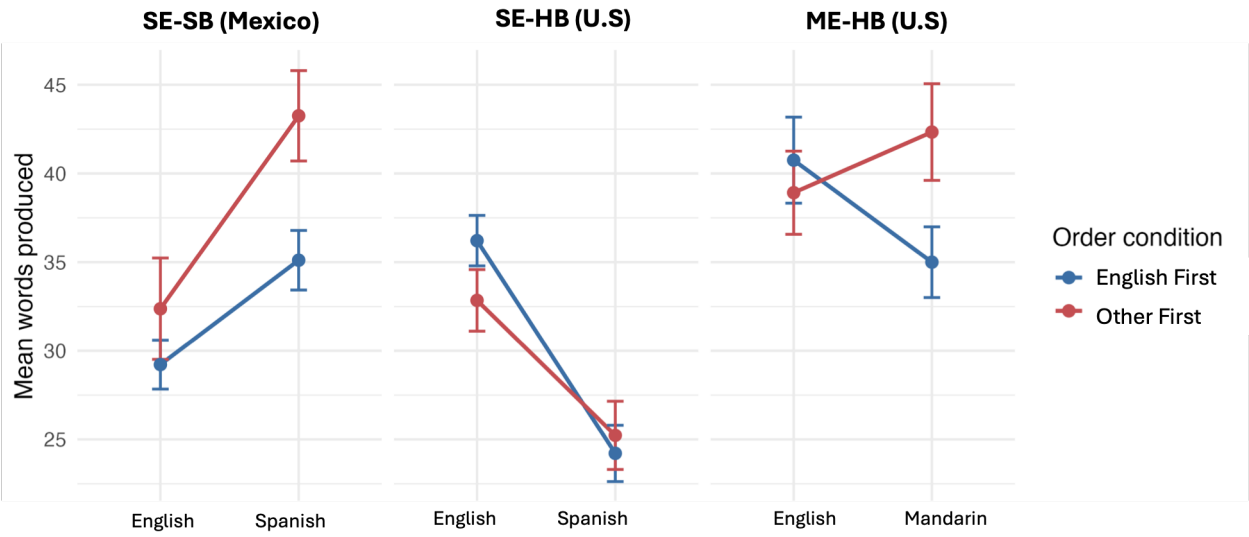
Groups did not differ significantly in closeness, $H(2, N = 73) = 1.03$, $p = .597$, $\varepsilon^2 = -.01$, and no pairwise contrasts approached significance (all $p_{adj} = 1.00$).

2.6.2 Verbal Fluency

Throughout this chapter, where nested models are compared via likelihood ratio test (LRT) alongside AIC and BIC, the LRT p-value is treated as the primary significance criterion, since it directly tests whether the added predictor(s) improve fit. AIC and BIC are reported as secondary checks on model parsimony; BIC penalizes complexity more heavily than AIC and will therefore sometimes favor a simpler model even when the LRT is significant. Where AIC, BIC, and the LRT disagree, I say so explicitly and explain which criterion is weighted more heavily and why, rather than defaulting silently to whichever criterion is most convenient for a given result.

English vs. Other-Language Fluency Within Each Group

Figure 4. *Verbal Fluency Performance by Language, Naming Order, and Group*



Note. Mean number of words produced on the verbal fluency task is shown by language, naming order (English-first vs. Other-language-first), and group. "Other language" refers to Spanish for the Spanish-English groups and Mandarin for the Mandarin-English group. Error bars represent ±1 standard error of the mean (SE).

To determine whether participants in each group produced more words in English or in their other language, paired comparisons (paired t-test, linear mixed-effects model with language as a within-subject fixed effect and a random intercept for participant) were conducted separately by group. The results summarized below can be seen visualized in Figure 4.

Spanish-English Sequential Bilinguals in Mexico (n = 34)

Participants produced significantly more (paired t-test) words in the other language (Spanish; $M = 38.9$, $SD = 9.50$) than in English ($M = 30.7$, $SD = 8.93$), $t(33) = -6.67$, $p < .001$, $d = -1.14$, 95% CI [-1.57, -0.70]. This is a large effect, indicating clear Spanish dominance in fluency among the sequential bilingual/non-broker comparison group.

Spanish-English Heritage Bilinguals in California (n = 27)

In contrast, this group showed the opposite pattern: significantly greater fluency in English ($M = 34.6$, $SD = 5.93$) than in the heritage language (Spanish; $M = 24.7$, $SD = 6.34$), $t(26) = 7.27$, $p < .001$, $d = 1.40$, 95% CI [0.86, 1.93]. This is also a large effect, indicating clear English dominance among the Spanish-English broker group.

Mandarin-English Heritage Bilinguals in California (n = 28)

No significant difference emerged between English ($M = 40.0$, $SD = 8.94$) and the heritage-language (Mandarin; $M = 38.1$, $SD = 9.23$) fluency, $t(27) = 0.73$, $p = .469$, $d = 0.14$, 95% CI [-0.23, 0.51]. This result suggests a relatively balanced fluency across both languages in this group.

Summary

The three groups showed different fluency profiles: the Mexico group was more fluent in Spanish (their dominant language in that context) than English; the Spanish-English heritage group showed the reverse pattern, with greater English fluency than Spanish (a typical heritage-dominance reversal); and the Mandarin-English heritage group showed no real asymmetry between English and Mandarin free recall verbal fluency ability. This pattern is consistent with the groups' differing language ecologies: sequential bilinguals in Mexico primarily using Spanish, Spanish-English heritage bilinguals in California showing a shift toward English dominance, and Mandarin-English heritage bilinguals showing relatively balanced bilingual fluency.

Order Effects

Prior research has shown that the order in which languages are tested can asymmetrically affect verbal fluency performance, with dominant-language fluency sometimes reduced when tested second, after the nondominant language, while nondominant-language fluency is less affected by testing order (Van Assche et al., 2013). To verify whether this pattern was present in the current data, order effects were tested separately for English and other-language fluency scores within each group.

Spanish-English Sequential Bilinguals in Mexico (n = 34)

Sequential bilinguals in Mexico experienced no reliable effect (lme) of naming order on English fluency, $F(1, 32) = 1.06$, $p = .31$, $\eta^2 = .03$ (English-first $M = 29.2$, heritage-language-first $M = 32.4$). However, order significantly affected other-language (Spanish) fluency, $F(1, 32) = 7.42$, $p = .010$, $\eta^2 = .19$, such that participants produced more Spanish words when they named in

Spanish first (M = 43.2, SE = 2.17) than when it was named second, after English (M = 35.1, SE = 2.05), b = 8.14, SE = 2.99, $t(32)$ = 2.72, p = .010.

Spanish-English Heritage Bilinguals in California (n = 27)

No order effects emerged for either language. English fluency did not differ by order, $F(1, 25)$ = 2.28, p = .144, η^2 = .08 (English-first M = 36.2, heritage-language-first M = 32.8), nor did heritage-language fluency, $F(1, 25)$ = 0.17, p = .686, η^2 = .007 (English-first M = 24.2, heritage-language-first M = 25.2). This group of heritage bilinguals showed no significant effect of verbal fluency language-block order.

Mandarin-English Heritage Bilinguals in California (n = 28)

Similar to the sequential bilinguals in Mexico, English fluency was unaffected by order for the Mandarin-English heritage bilinguals, $F(1, 26)$ = 0.28, p = .601, η^2 = .01 (English-first M = 40.8, heritage-language-first M = 38.9). Heritage-language (Mandarin) fluency, however, again showed a significant order effect, $F(1, 26)$ = 4.96, p = .035, η^2 = .16: producing Mandarin first yielded higher fluency (M = 42.3, SE = 2.49) than producing it second, after English (M = 35.0, SE = 2.16), b = 7.33, SE = 3.29, $t(26)$ = 2.23, p = .035.

Summary

Across all three groups, English fluency was unaffected by naming order; participants produced a comparable number of English words whether English was named first or second. Other-language fluency, by contrast, was order-sensitive in two of the three groups (the Mexico sequential bilinguals and the Mandarin heritage bilinguals): other-language scores were higher when that language was produced first and dropped when it followed English. This pattern was absent in the Spanish heritage bilingual group, where heritage-language (Spanish) fluency was

stable regardless of order. This may reflect an interference from having just produced in the dominant, societal language (English) -- an effect that was not observed for Spanish among the Spanish-English broker group. This raises the question about whether orthographic differences or differences in code-switching practices between the two heritage groups contribute to this divergence.

2.6.3 Picture Naming Reaction Time

Spanish-English Sequential Bilinguals in Mexico (n = 34)

There was no significant difference (paired t-test) between English (M = 1397 ms, SD = 261) and other-language (M = 1386 ms, SD = 285) naming speed, $t(33) = 0.33$, $p = .747$, d = 0.06, 95% CI [-0.28, 0.39]. This group did not name faster in English, so the reaction times in the two languages were similar.

Spanish-English Heritage Bilinguals in California (n = 27)

Participants were significantly faster in English (M = 1273 ms, SD = 210) than in Spanish (M = 1,409 ms, SD = 194), $t(21) = -3.27$, $p = .004$, d = -0.70, 95% CI [-1.16, -0.22]. This is a medium-to-large effect, indicating a clear English speed advantage for this group.

Mandarin-English Heritage Bilinguals in California (n = 28)

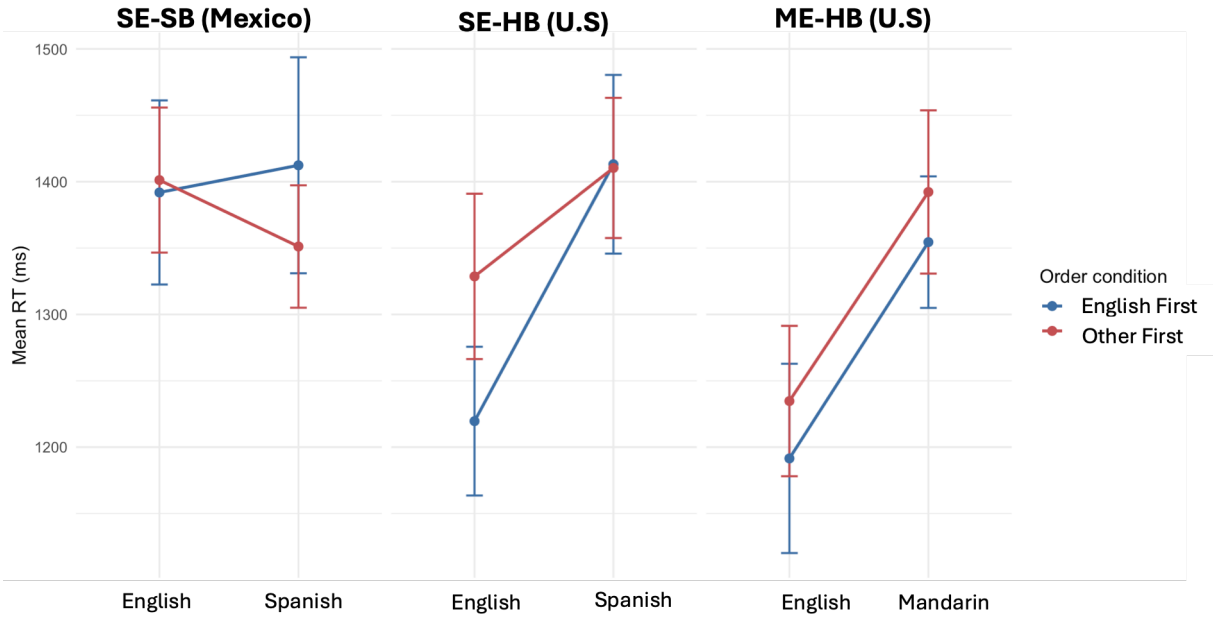
Participants were also significantly faster in English (M = 1204 ms, SD = 244) than in Mandarin (M = 1365 ms, SD = 209), $t(27) = -3.47$, $p = .002$, d = -0.66, 95% CI [-1.06, -0.24]. This is a comparably large effect, again favoring English.

Summary

The English speed advantage was driven entirely by the two heritage-bilingual groups (Spanish-English and Mandarin-English), both of which named significantly faster in English than in their heritage language, with medium-to-large effect sizes. The Mexico (sequential bilingual) group showed no advantage, such that English and Spanish naming speed were statistically similar there. This pattern of results across groups is suggestive of a Group × Language interaction, though this was not formally tested via an omnibus model here; the three separate within-group comparisons above should be read as descriptively, rather than statistically, converging on that conclusion.

Order Effects

Figure 5. *Picture-Naming Reaction Time by Group, Language, and Order Condition*



Note. Mean reaction time (RT; ms) for correct picture-naming trials is shown by group, language, and order condition (English-first vs. Other-language-first). Reaction times were cleaned prior to analysis. "Other language" refers to Spanish for the Spanish–English groups and Mandarin for the Mandarin–English group. Error bars represent ±1 standard error of the mean (SE).

To test whether naming order affected each language's reaction time specifically, separate models (reaction time regressed on picture-naming order) were fit within each group × language combination. To obtain these results, I only looked at accurate responses, free of false reaction times, and for pure language blocks. Results are presented in Figure 5.

Spanish-English Sequential Bilinguals in Mexico (n = 34)

Naming order had no effect (ANOVA) on reaction time for either language: English, $F(1, 32) = 0.03$, $p = .854$, $\eta^2 = .001$ (English-first $M = 1{,}389$, other-first $M = 1{,}406$); Spanish, $F(1, 32) = 0.46$, $p = .503$, $\eta^2 = .01$ (English-first $M = 1{,}418$, other-first $M = 1{,}351$). While this null pattern was not what was initially expected, part of the explanation may lie in the artificial testing immersion imposed on this group, discussed further in the Interim Discussion.

Spanish-English Heritage Bilinguals in California (n = 27)

Order showed no significant effect on English reaction time, $F(1, 22) = 2.30$, $p = .144$, $\eta^2 = .09$, though the direction hinted at slower English naming when English was named second (English-first $M = 1{,}204$, other-first $M = 1{,}331$). This was a non-significant effect worth noting given the sample size, such that future directions with higher sample size may reach significance. Heritage-language reaction time was unaffected by order, $F(1, 20) = 0.02$, $p = .885$, $\eta^2 = .001$.

Mandarin-English Heritage Bilinguals in California (n = 28)

Order had no significant effect on either language: English, $F(1, 26) = 0.22$, $p = .646$, $\eta^2 = .008$; heritage language, $F(1, 26) = 0.22$, $p = .642$, $\eta^2 = .008$.

Summary

Naming order had no significant effect on reaction time in any of the three groups, in either language. The Mexico (sequential bilingual) group showed no order effect for English or Spanish. The Spanish-English heritage group showed no significant order effect in either language, though English naming trended slower when named second; this was a small effect that may reflect the sample size. The Mandarin-English heritage group also showed no order effect in either language. Overall, order effects were essentially absent across all three groups, with only a non-significant hint of one in the Spanish-English heritage sample.

One plausible explanation for the absent order effect in the Mexico group is a testing-language confound rather than a true absence of regulation. The heritage groups were administered the tasks and instructions in English, their dominant language, while the sequential bilinguals were tested in English, their non-dominant language. This was a design choice to keep experiment materials consistent but may turn out to be a limitation of the study. In this case, it would be difficult to disentangle a true regulation pattern since participants must regulate their dominant language from the moment they stepped into the lab. Order effects in picture naming are conventionally treated as an index of language regulation, so the largely null pattern across all three groups suggests regulatory demands in this task weren't strong enough to produce a detectable order cost at these sample sizes.

Picture Naming and Language Brokering

To test whether picture naming reaction time varies as a function of childhood and adulthood brokering experience, model comparison (Likelihood Ratio Test, Akaike Information Criterion; AIC and Bayesian Information Criterion; BIC) was used to evaluate whether adding each brokering variable improved fit over a baseline model containing language, group, and language order (and their interactions), restricted to the two brokering groups (Spanish-English

and Mandarin-English heritage bilinguals; N = 33 participants, 1,536 trials). Brokering variables were first included additively, then allowed to fully interact with language, group, and order, and both were compared against the no-brokering baseline.

Childhood brokering

Adding childhood brokering as a simple additive predictor did not improve fit over the baseline model, $\chi^2(1) = 0.14$, $p = .707$. Allowing childhood brokering to interact fully with language, group, and order did not significantly improve fit over the additive model, $\chi^2(7) = 13.73$, $p = .056$, though this approached conventional significance, nor over the baseline overall, $\chi^2(8) = 13.87$, $p = .085$. AIC showed no preference between the baseline and interactive models (22,809.66 vs. 22,811.78), while BIC favored the baseline model (22,863.02 vs. 22,907.85). Given the LRT was non-significant and BIC favored the simpler model, the baseline model, with no meaningful role for childhood brokering, was judged the best-fitting account of the data.

Adulthood brokering

Adding adulthood brokering additively did not improve fit over baseline, $\chi^2(1) = 0.005$, $p = .944$. Allowing it to interact fully with language, group, and order also did not significantly improve fit over the additive model, $\chi^2(7) = 12.12$, $p = .097$, nor over baseline overall, $\chi^2(8) = 12.12$, $p = .146$. Both AIC (22,809.66 vs. 22,813.53) and BIC (22,863.02 vs. 22,909.60) favored the baseline model. As with childhood brokering, the baseline model was judged the best fit, indicating no reliable contribution of adulthood brokering experience to picture naming RT.

Summary

Neither childhood nor adulthood brokering meaningfully predicted picture naming reaction time, whether tested additively or in full interaction with Language, Group, and Order.

This pattern held under both AIC and BIC. The regulation-cost hypothesis linking brokering experience to naming-order effects was not supported in this dataset.

2.6.4 Picture Naming Accuracy

Childhood Brokering

I tested whether the amount of brokering people did as children changed the gap between English and heritage-language naming accuracy (the "gap" being how much more accurate people are in English than in their heritage language). Adding childhood brokering to the model did not improve it at all, $\chi^2(1) = 0.0005$, $p = .982$. Testing whether brokering changed the size of the language gap specifically (rather than accuracy overall) also came back non-significant, $b = 0.23$, $SE = 0.15$, $p = .127$. More childhood brokering hinted at a slightly larger English-accuracy gap, not a smaller one, though this did not reach significance.

Adulthood Brokering

The same pattern held for brokering done as an adult. Adding adulthood brokering to the model did not improve it, $\chi^2(1) = 0.16$, $p = .686$, and the effect on the language gap specifically was also non-significant, $b = 0.15$, $SE = 0.11$, $p = .189$. Again, the (non-significant) direction leaned toward a larger gap with more adult brokering, not a smaller one.

Summary

Brokering experience, whether measured in childhood or adulthood, had no significant effect on picture naming accuracy in Study 1, either on accuracy overall or on the size of the English-heritage accuracy gap specifically. Given the more smaller sample size here ($n = 34$) and the complexity of the statistical model, this null pattern is inconclusive but should not be

considered as evidence that brokering has no effect; it may simply reflect that Study 1 was not sufficiently powered to detect an effect of this kind, an issue discussed is further in the limitations.

Having established each group's production profile in verbal fluency and picture naming, I turn next to the translation recognition task, the central task of this dissertation and the one most directly tied to the predictions about language brokering laid out above.

2.6.5 Translation Recognition

Reaction Time: Group × Stimulus Type

Figure 6. *Translation Recognition by Group and Condition Type*

Note. Mean reaction time (RT; ms) for correct translation recognition trials is shown by group, language, and distractor condition type (form related, semantic related, and unrelated). Reaction times were cleaned prior to analysis. SE-SB = Spanish-English sequential bilinguals in Mexico; SE-HB = Spanish-English heritage bilinguals in the United States; ME-HB = Mandarin-English heritage bilinguals in the United States.

A linear mixed-effects model was fit to translation recognition reaction times (correct trials only, cleaned) with fixed effects of stimulus type (unrelated, form related, semantic related), group, and their interaction, with a random intercept for participant. Results are shown visually in Figure 6. Analyses exclude performance on the correct translation pairs and instead center on using the unrelated pairs as the baseline against which to measure performance of the semantic related and form related distractors per previous literature.

There was a significant main effect of stimulus type, $F(2, 10814.2) = 151.49$, $p < .001$. Across all groups, participants were slowest on semantic-related trials and fastest on unrelated trials, with form-related trials falling in between. This is the expected interference pattern in which semantic overlap with the target creates the most competition during recognition, particularly for high-proficiency bilinguals.

There was also a significant main effect of group, $F(2, 85.5) = 10.64$, $p < .001$. Collapsing across stimulus type, Mandarin-English brokers were fastest to resolve distractors overall, the Mexico group was intermediate, and Spanish-English brokers were slowest. This result may allude to the impact of language pairs across groups; Mandarin and English are languages that are more distinct in form than Spanish and English; therefore, it may be that this larger distinction is driving the ease of resolving translation distractors faster. The group × stimulus type interaction was also significant, $F(4, 10814.2) = 2.89$, $p = .021$, indicating that the general slowing pattern across stimulus types held for all three groups.

Effects for stimulus type within each group showed that all three groups exhibited the same ordering. More specifically, all groups resolve unrelated distractor pairs the fastest, followed by lexical form related distractors, and resolution of semantic distractors taking the longest amount of time. Majority of the related pairwise comparisons were significant within

every group (all *p*s < .001), with the exception of form-related versus semantic-related in the Mandarin-English group ($p = .007$) and unrelated versus form-related in the Spanish-English group ($p = .008$), which were still significant but reflected comparatively smaller gaps.

The effects for group within each stimulus type showed that the group ordering was consistent across all three stimulus types: Mandarin-English brokers were significantly faster than both other groups at every stimulus type (Mandarin-English vs. Spanish-English in Mexico and Mandarin-English vs. Spanish-English heritage bilinguals: all *p*s < .02). Spanish-English heritage bilinguals were significantly slower than Mandarin-English heritage bilinguals throughout (all *p*s < .001) and were numerically, but not significantly, slower than the Mexico group at every stimulus type; this Mexico-versus-Spanish-English gap reached only marginal significance for unrelated trials ($p = .065$, not significant after correction) and did not reach significance for form-related ($p = .302$) or semantic-related ($p = .097$) trials.

Summary

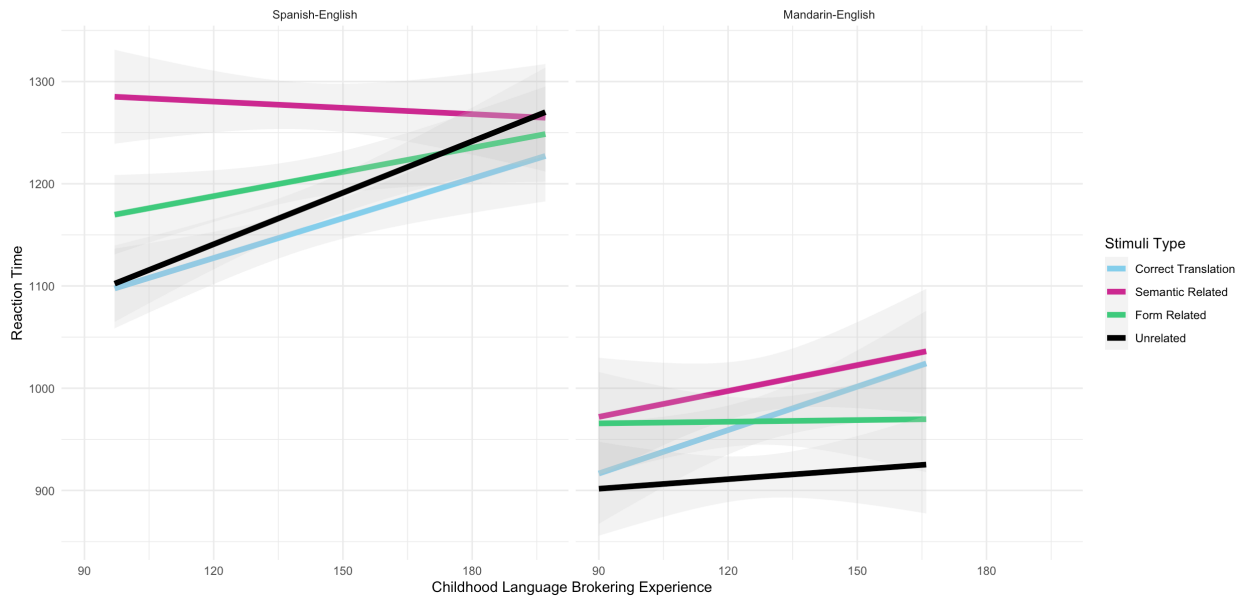
All three groups showed the expected interference pattern across stimulus types (unrelated fastest, semantic-related slowest), and this pattern was broadly consistent across groups. The interaction effect was statistically significant, but it reflects only subtle differences in the size of that gradient rather than a qualitatively different pattern for any group. The main takeaway here is the main effect of group: Mandarin-English brokers were faster overall than both Spanish-speaking groups, while the Mexico and Spanish-English broker groups performed similarly to each other. Critically, and consistent with Ferré et al., these relatively proficient bilinguals also showed form-related translation effects which is an interference pattern that is typically associated with lower-proficiency processing, suggesting that even skilled bilinguals do not fully suppress form-level co-activation during translation recognition.

Reaction Time and Language Brokering: Childhood vs. Adulthood (Spanish-English and Mandarin-English Brokers)

To test whether translation recognition reaction time varies as a function of childhood and adulthood brokering experience, model comparison (AIC and BIC tests) was used to evaluate whether adding each brokering variable. It is important to note that the AIC and BIC criterion are used to select models but differ in a significant way: BIC is more stringent on greater complexity. Therefore, both will be used complementarily, but may yield slightly different interpretations. First, the brokering variables were included additively, and then they were included to fully interact with stimulus type and group. These were also compared to a baseline model that did not include the factor of language brokering.

Childhood brokering

Figure 7. *Translation Recognition by Group, Condition Type and Childhood Brokering*



Note. Reaction time in milliseconds.

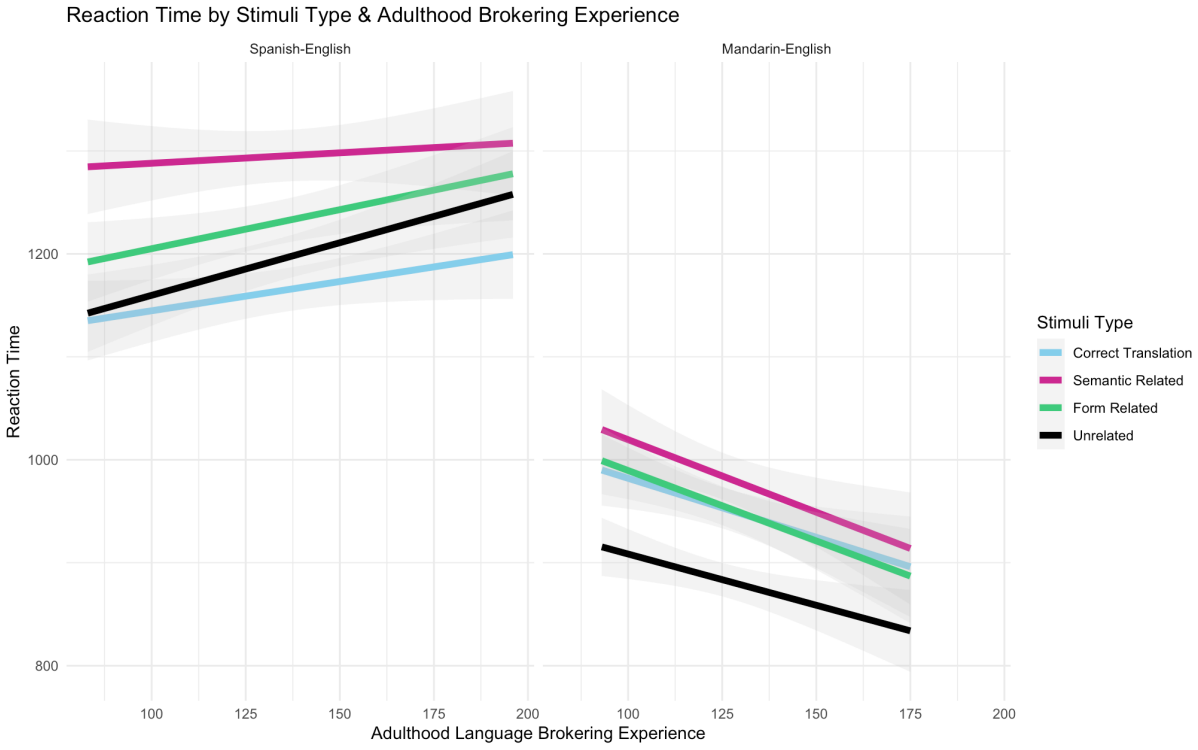
Childhood brokering and translation recognition results are represented visually in Figure 7. Adding childhood brokering as a simple additive predictor did not improve fit over the no inclusion of brokering baseline model, $\chi^2(1) = 0.17$, $p = .684$. However, allowing childhood brokering to interact with stimulus type and group significantly improved fit over the additive model, $\chi^2(5) = 15.94$, $p = .007$, and over the baseline overall, $\chi^2(6) = 16.10$, $p = .013$. AIC favored the fully interactive model (70,604.58 vs. 70,608.68 for the baseline), whereas BIC favored the baseline model (70,696.00 vs. 70,660.92). Given these results, the fully interactive model was perceived to be of best fit to the data.

In the winning fully interactive model, a three-way interaction between stimulus type, group, and condition was significant, $F(2, 5013.9) = 4.27$, $p = .014$. This was driven specifically by semantic-related trials: the childhood-brokering slope on semantic-related reaction time differed significantly by group ($b = 2.33$, $SE = 0.84$, $t = 2.78$, $p = .005$), and childhood brokering's relationship with reaction time was significantly different for semantic-related trials relative to the unrelated baseline ($b = -1.67$, $SE = 0.45$, $t = -3.71$, $p < .001$). This three-way interaction indicates that the effect of childhood brokering on translation recognition is not uniform across groups or stimulus types but is concentrated in the semantic-related condition. In other words, childhood brokering experience appears to selectively shape how bilinguals resolve semantic-level interference during translation recognition, rather than exerting a general effect on processing speed across all trial types.

Adulthood brokering

Adulthood brokering showed no evidence of improving the model fit at any level. Neither the additive model, $\chi^2(1) = 0.06$, $p = .809$, nor the fully interactive model, $\chi^2(5) = 6.50$, $p = .260$ (vs. additive) and $\chi^2(6) = 6.56$, $p = .363$ (vs. baseline), improved on the simpler baseline. Both AIC and BIC favored the no-brokering model. Therefore, the final model was that of reaction time regressed on stimulus type and group with a random intercept for participant; adulthood brokering was dropped entirely. Simple slopes were null throughout. Results are presented in Figure 8. In contrast to childhood brokering, adulthood brokering showed no evidence of predicting translation recognition performance at any level, additive or interactive, and was therefore dropped from the final model.

Figure 8. *Translation Recognition by Group, Condition Type and Adulthood Brokering*



Note. Reaction time in milliseconds.

Summary

Childhood brokering, but not adulthood brokering, demonstrate an association with stimulus type for reaction time on the translation recognition task. This effect emerges through an interaction with stimulus type and group, rather than a predictor in and of itself. Adulthood brokering showed no relationship with reaction time at any level of model complexity. This childhood versus adulthood dissociation is consistent with the pattern observed across the other Study 1 tasks: childhood brokering experience carries measurable weight for cognitive-linguistic outcomes, whereas adulthood brokering does not. This dissociation suggests that the influence of language brokering on language co-activation, at least in regard to the type of processing demands required by the translation recognition task, is specific to brokering experience acquired during childhood, rather than reflecting a general effect of ever having brokered. These findings suggest that across distinct language ecologies, the impact of language brokering in childhood cannot be conflated with that experience in adulthood.

2.7 Interim Discussion

Taken together, the Study 1 findings show that language brokering and interactional context each leave a distinct signature on bilingual language processing. However, their marks are not always in the uniform pattern of brokers outperforming non-brokers that I predicted at the outset. Instead, the results point to a more nuanced picture in which everyday language ecology, language-pair typology, and the developmental timing of brokering experience may each contribute independently to performance.

Language Dominance as a Reflection of Interactional Context

The Verbal Fluency and Picture Naming results reflect the three groups' distinct interactional contexts more than a single underlying "bilingual" profile. The Mexico group, whose daily use of English is largely confined to academic and professional domains, showed clear Spanish dominance in both fluency and naming speed. The Spanish-English brokers in California, by contrast, showed the classic heritage-bilingual dominance shift toward English, and the Mandarin-English brokers showed a comparatively balanced profile, faster in English than Mandarin for naming but statistically indistinguishable in fluency output. This pattern is consistent with an interactional-context account of bilingual language processing (Beatty-Martínez et al., 2020): language dominance is not a fixed trait of the individual but one that emerges from the structure of the environments in which each language is used, practiced, and required.

The order effects in verbal fluency reinforce this idea. Producing the other language first boosted other language output for the Mexico and Mandarin-English groups, while English output was unaffected by order in every group. For the Mandarin-English brokers, this asymmetry fits a language regulation account in which recent use of the dominant, societal language (English) suppresses subsequent access to the less-practiced language, whereas the reverse does not hold because English is rarely, if ever, the language under active suppression in these participants' daily lives (Green, 1998; Green & Abutalebi, 2013).

The Mexico group presents a different case because Spanish, not English, is their societally dominant L1, and English is a later-learned, less-practiced L2 rather than a heritage language. That this group shows the same order sensitivity suggests the effect is not only a heritage-language phenomenon or a matter of which language is societally dominant. Instead, it may reflect something more general about English's role across groups: regardless of whether

English is the participant's dominant or non-dominant language, it appears resistant to order effects, while the other language (heritage or L1) does not.

Notably, this order sensitivity was absent for the Spanish-English broker group's heritage language. One possibility is that the sustained, bidirectional translation demands of brokering keep Spanish more continuously accessible for this group, such that it is less vulnerable to short-term interference from having just produced English. But knowing whether this reflects brokering specifically, or another feature of this group's language ecology, cannot be determined from the current design and is a direction for future work isolating brokering from heritage-language pair.

Group Differences in Translation Recognition: Interactional Context Over a General Brokering Advantage

The translation recognition results did not support the prediction that brokering confers a general translation-recognition advantage. If brokering itself sped access to translation equivalents, both broker groups should have outperformed the Mexico non-brokers. Instead, the Mandarin-English brokers were fastest overall, Mexico was intermediate, and Spanish-English brokers were slowest. The result found was the opposite of a simple brokers-versus-non-brokers ordering.

One potential source of this pattern in differences may lie in the habitual interactional context rather than brokering status per se. A one-way ANOVA revealed a significant difference in code-switching frequency (extracted from the social network questionnaire) between the two heritage groups, $F(1, 56) = 4.72$, $p = .034$, with Spanish-English heritage bilinguals ($M = 1.10$, $SD = 0.66$) code-switching more frequently than Mandarin-English heritage bilinguals ($M =$

0.78, SD = 0.46). Under adaptive control accounts of bilingual language regulation (Green & Abutalebi, 2013), bilinguals embedded in denser code-switching contexts may rely on a different strategy of language regulation. This shift in regulatory strategy could manifest as slower or more competitor-sensitive responding during translation recognition, offering a possible account of the Spanish-English heritage group's slower performance. This account would also explain Mexico's intermediate position: as sequential bilinguals recruited from a Spanish-dominant context, this group's interactional profile may differ meaningfully from the denser, more bidirectional code-switching environment of the California heritage-broker community.

A cross-language similarity account is a secondary possibility. Spanish and English's greater orthographic and phonological overlap relative to Mandarin and English could potentially elevate competitor activation. However, this dissertation did not test this directly, and establishing it would require more refined evidence, such as direct comparisons of cognate versus non-cognate item performance or independent measures of cross-language phonological/orthographic distance. In this way, the code-switching account offers the more grounded explanation for the observed group ordering.

At the same time, all three groups showed the expected interference gradient across stimulus types (unrelated fastest, semantic-related slowest), indicating that the basic architecture of translation recognition task, and most specifically the greater competition introduced by semantic overlap with the target, operates similarly regardless of group or brokering status. Brokering experience, in other words, does not appear to change which kind of distractor is hardest to reject; it may instead operate on top of this shared architecture in a more targeted way, which is the pattern that emerged in the childhood versus adulthood brokering analyses discussed next. It is worth noting, however, that the translation recognition task is not itself an act of

translation, nor does it capture the social or interactive dimensions of real-world language brokering; it isolates a narrower cross-language lexical competition process that brokering experience may draw on, without claiming to simulate brokering as it actually occurs.

Childhood Versus Adulthood Brokering

The clearest evidence that brokering experience matters for translation recognition performance came not from group membership but from the childhood/adulthood dissociation within the two broker groups. Childhood brokering interacted with stimulus type and group, driven specifically by semantic-related trials, whereas adulthood brokering showed no relationship with reaction time at any level of model complexity. This dissociation is consistent with a developmental account in which brokering experience that begins earlier in life while the language system is still maturing becomes embedded in the architecture of lexical-conceptual links between L1 and L2; in turn, this leads to the strengthening of the shared conceptual links posited by the Revised Hierarchical Model (Kroll & Stewart, 1994) and in doing so increases sensitivity to semantic competitors specifically. Brokering that begins in adulthood, after these lexical-conceptual links are already established, would be expected to leave a comparatively shallow imprint on real-time lexical access, which is consistent with the null results observed here. This pattern also offers a possible resolution to the other group-level findings : brokering's cognitive-linguistic signature may be real but concentrated in participants with childhood experience and diluted at the group level by brokers whose experience began later. These results suggest that language brokering experience does not have a uniform influence on bilingual language processing, but rather selectively predicts performance on tasks that place specific demands on the bilingual language control system. Childhood brokering interacted with stimulus type and group in the translation recognition task, while neither childhood nor adulthood

brokering meaningfully predicted performance on the picture naming (PN) task, despite both tasks drawing on the same underlying bilingual populations and, in several cases, the same participants.

One possible explanation for this dissociation lies in the differing control demands inherent to each task. Translation recognition requires the simultaneous activation and comparison of lexical representations across both languages: participants must hold a target word active while evaluating a probe for semantic or formal relatedness, a process that inherently requires the co-activation and joint engagement of both linguistic systems. On the other hand, picture naming is a fundamentally a single-language production task: on each trial, participants must select and articulate a name in one designated language while suppressing the competing response from the non-target language. Under models of bilingual language control that distinguish between processing contexts based on the degree of language co-activation they require (e.g., the Adaptive Control Hypothesis; Green & Abutalebi, 2013), translation recognition more closely proxies a "dual-language" context where one in which both languages remain simultaneously engaged and must be jointly coordinated while PN more closely approximates a "single-language" context, in which control is exercised primarily through the competitive suppression of one language in favor of the other.

Language brokering, as an activity, may be uniquely suited to strengthen the kind of control recruited by bilinguals in dual-language contexts. The act of brokering in and of itself does not only require a broker to alternate between using one language and suppressing the other in sequence; rather, brokering requires the real-time, simultaneous engagement of both languages. Brokers will hold a message in one language active while producing its equivalent in another, often while monitoring both languages for accuracy and appropriateness. This role is

closer to the demands of translation recognition than to those of picture naming. If brokering experience selectively tunes control processes recruited during simultaneous dual-language engagement, rather than control processes recruited during single-language selection and suppression, this would predict precisely the pattern observed here: a brokering-related advantage on translation recognition, a task that taps joint bilingual activation, and no corresponding advantage on picture naming, a task that instead taps competitive selection within a single target language.

This interpretation is consistent with a broader view in the bilingualism literature that language control is not a unitary construct, but a set of dissociable processes recruited differentially depending on the interactional demands of the context (e.g., single-language, dual-language, and code-switching contexts each engaging distinct control configurations). Under this view, the absence of a brokering effect on picture naming is not merely a null result to be explained away but may itself be theoretically informative: it suggests that the cognitive consequences of language brokering are not general-purpose enhancements to bilingual control, but are instead specifically tied to the kind of simultaneous, dual-language coordination that brokering itself requires.

The present findings suggest that language brokering does not operate as a uniform, all-or-nothing experience with a single behavioral signature. Instead, its consequences for language processing appear to depend on when brokering began, which language pair is involved, and the broader interactional context in which each group's languages are used on day-to-day basis. This reframes the guiding question of this dissertation: rather than asking whether brokers outperform non-brokers, a more productive question is which dimensions of brokering experience (period across the lifespan of brokering, continuity, language-pairs) leave lasting traces in the bilingual

language system, and through what mechanisms. Study 2 takes up this question with a finer-grained, electrophysiological measure of lexical and semantic access within a single broker population.

Chapter 3: Study 2 — Electrophysiological Correlates of Language Brokering

3.1 Introduction – EEG

The use of electrophysiological methods, particularly ERPs, is crucial for understanding the real time cognitive processes involved in bilingual language processing. ERPs provide high temporal resolution, which allows us to assess language processing as it unfolds. Having the fine-grained temporal resolution of ERPs affords the present study wither greater precision than behavioral methods alone. ERPs have been well-documented for their sensitivity to the time course of processing the meaning of words in the brain (Ma et al., 2017; Guo et al., 2012). More importantly, ERPs provide a nuanced understanding of the time course of language processing; they often reveal comparable behavioral patterns alongside differing ERP patterns (Grey et al., 2018; Thierry & Wu, 2007). Using ERPs in the context of language brokering, where bilinguals are required to switch between languages rapidly under time pressure to serve as intermediaries for their families and communities may be an invaluable tool to better understand the complex and dynamic cognitive processes involved in their language processing.

3.1.1 Prior ERP Work on Translation Recognition and the N400/LPC Dissociation

The clearest guide for what Study 2 should expect electrophysiologically comes from a small set of ERP studies that have adapted the translation recognition paradigm across different bilingual populations and language pairs. The paradigm this study most closely follows, in both structure and analytic approach, is Guo and colleagues (2012), who examined Chinese-English

bilinguals judging translation pairs against unrelated, form-related, and semantically related distractors. Semantic distractors modulated both the N400 and the LPC relative to unrelated controls, while form distractors elicited a larger P200 and LPC. Critically, the LPC effects of semantic and form distractors ran in opposite directions over posterior versus anterior scalp regions, establishing the anterior/posterior distinction that later studies have retained in their analysis approach.

Subsequent studies extended this paradigm to other language pairs and consistently reproduced the same basic dissociation. Ma et al. (2017) tested late English-Spanish bilinguals using the same three distractor types at two stimulus onset asynchronies (SOA). At the longer SOA, semantic distractors elicited a smaller N400 and a larger LPC relative to unrelated controls, while form distractors elicited a larger P200 and LPC without the same N400 modulation, closely replicating Guo et al.'s original pattern. Moldovan et al. (2016) reported a comparable dissociation in highly proficient Spanish-Catalan bilinguals, where N400 amplitude tracked the graded degree of semantic similarity between distractor and target, while form-related translation neighbors selectively modulated the LPC. Ferré et al. (2023) extended this Spanish-Catalan design further, using a task structure close to the one adopted here and again found semantic distractors localized to the N400 and form distractors localized to the LPC. Across four studies spanning three distinct language pairs, the same general pattern occurs: semantic relatedness modulates the N400, and form relatedness modulates the LPC. This cross-study consistency is the motivation for Study 2 and is used to now assess whether language brokering experience leaves a mark on this well-established time course.

3.1.2 Lexical Level

At the lexical level, ERPs allow for the examination of how bilingual individuals process individual words, particularly in situations where both languages are involved. In a recent study, Ferré et al. (2023) sought to examine lexical level processing in bilinguals utilizing ERPs. They presented Catalan-Spanish bilinguals with a translation recognition task to examine the activation of translation equivalents in the minds and brains of bilinguals. In this experiment, participants were asked to determine whether the pair of words (one in Catalan and one in Spanish) were correct translations of each other. They included four conditions: a correct translation condition, a semantic related distractor condition, a form-related distractor condition and a completely unrelated incorrect condition. They captured behavioral measures by way of accuracy and reaction time performance. ERPs were also recorded per participant, with a focus on assessing the N400 and LPC, which they determined a priori per previous literature. The N400 was time locked from 300 millisecond to 500 milliseconds and the LPC was time locked from 500 milliseconds to 700 milliseconds. The N400 component has been associated with semantic processing (Kutas & Federmeier, 2000), while the LPC has been associated with response monitoring, reanalysis of information processing, and decision making (Kolk & Chwilla, 2007). Observed modulations in the LPC during translation recognition tasks specifically have been thought to reflect a check on the decision to reject semantic-related and form-related distractors (Ma et al., 2017).

Ferre et al., (2023) found significant interference effects in both reaction times and errors, particularly in the semantic-related condition compared to the form-related condition. ERPs revealed modulations in the N400 component, where unrelated words elicited a more negative-going wave compared to semantically related words. Additionally, the form manipulation affected the LPC component, with unrelated words eliciting a more positive-going wave

compared to form-related words. These results emphasize the value of using ERPs to examine the temporal dynamics of lexical processing as they reveal initial stages of processing that might not be captured by behavioral measures alone (van Hell & Kroll, 2012). Ferre et al.'s experimental paradigm served as the basis for the present dissertation study, particularly in setting the a priori ERP component time windows and regions of interest (ROIs).

3.2 Research Site and Participants

Study 2 recruited Spanish-English heritage bilinguals in Irvine, California, all of whom have engaged in language brokering to some degree. Unlike Study 1, which compared distinct groups defined by brokering status and language pairs, Study 2 holds the language pair constant with Spanish and English. Instead, the present study sampled continuously across the full range of brokering experience, from minimal to extensive, and across both childhood and adulthood brokering experiences. This design allows brokering experience to be modeled as a continuous predictor of neural and behavioral performance, rather than compared across dichotomous groups. In doing so, this study complements the group comparison approach that was taken in Study 1.

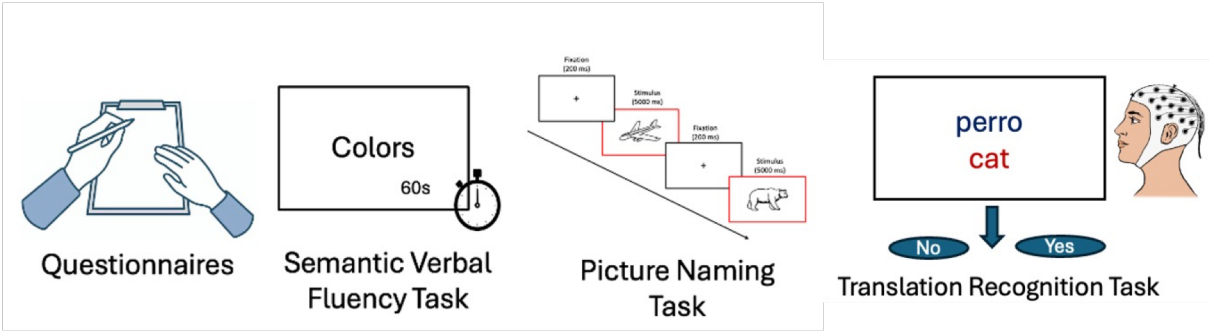
3.3 Task Battery

Questionnaires utilized in the present task battery are created and hosted in the Gorilla Experiment Builder platform (Anwyl-Irvine, 2020). For the behavioral tasks of these studies, participants' performance data (accuracy and reaction time) are recorded on E-Prime 3.0 software, a software package for designing and running psychological experiments (Psychology Software Tools, 2016).

The task battery consists of a language experiences questionnaire (the BLP), a verbal fluency task, a picture naming task, a social network questionnaire, and the translation recognition task.

Study 2 was divided into two data collection sessions: Session 1 consisted of the same behavioral task battery administered in Study 1, and Session 2 consisted of the EEG recording portion. This two-session structure accounted for the time required for EEG capping and helped ensure that participants were not fatigued and could maintain focus throughout the task. Experimental task battery schematic for Study 2 is included in Figure 9.

Figure 9. *Experimental task battery for Study 2*



3.3.1 Language Experiences Questionnaire

Participants complete two questionnaires to capture their language experiences. I administer the Bilingual Language Profile (BLP; Birdsong et al., 2012) which is a self-report of bilingual language dominance. The BLP produces a score of dominance which is crucial for the experiences of heritage bilinguals whose language dominance often shifts across the lifespan. This questionnaire is also adapted to include questions about the construct of language entropy (Gullifer & Titone, 2019), which offers insight to the social diversity of language usage.

Subsequently, participants complete a questionnaire on the range of their language brokering experiences. The questionnaire was designed by compiling questions from previous studies on language brokering (Kim et al., 2017; López, 2015) and adding additional questions that offer a more comprehensive understanding of the frequency and continuity of brokering across the lifespan. I capture whether language brokering was a static experience that only occurred in childhood, or whether language brokering persists in adulthood, a feature that no previous research, to our knowledge, has captured. The language brokering questionnaire has not only been designed to allow us to assess group binary differences between language brokers and non-language brokers, but more crucially to also examine the variation within the language brokering population in a way that has not been the focus of previous research. It is important to note that utilizing this more extensive language brokering questionnaire is exploratory in nature but may yield insights for research on language brokering moving forward.

3.3.2 Social Network Questionnaire

Both studies also included a social network questionnaire, which aims to assess participants' social interactions and linguistic practices. Bilingual participants provide details about their personal social networks using Network Canvas (Complex Data Collective, 2016). Participants are asked to identify 15 people they regularly interact with in their daily lives. For each person, they answer a series of questions about how often they communicate and the emotional closeness they share, which helps assess the strength of their relationship. They also indicate the social contexts (e.g., family, work, school) and communication methods (e.g., in person, instant messaging) they use when engaging with each individual. Additionally, participants note which language(s) they typically use when interacting with each person. This questionnaire provides insights into participants' language use in social contexts, offering data

on how language proficiency and social integration may influence translation processing. Through use of social network science, I hope to gain a deeper understanding of the social factors, beyond language brokering itself, that contribute to bilingual individuals' translation abilities.

3.3.3 Verbal Fluency Task

Participants complete a measure of verbal fluency. In this task, participants are given a block of categories in Spanish, and English, respectively with the order of presentation counterbalanced. Eight semantic categories (four in each language) are with counterbalancing occurring across participants. Participants have 30 seconds to list as many exemplars per category in the indicated language.

3.3.4 Picture Naming Task

Language production abilities were assessed with a picture naming task. In this task, participants name a total of 160 black and white drawings in Spanish and English, respectively. The pictures for this task have been picked from an online normed database, the International Picture Naming Project (Szekely et al., 2004) and these are matched in terms of visual complexity, frequency, and semantic category. The procedure for this task includes two pure language blocks and one mixed language blocks. Participants name 40 pictures in the pure Spanish block, 40 pictures in the pure English block, and switch between naming 40 pictures in Spanish and 40 pictures in English in the mixed language block. They are instructed to name pictures in each of their two languages based on the color of the picture frame (red or blue) which is counterbalanced across participants. The order of the homogenous language blocks is randomly counterbalanced, such that half of the participants name in pictures in a pure Spanish

block first and the other half names pictures in a pure English block first. In the heterogenous language-switching block, participants do not have to name pictures in a single language for more than three consecutive trials to ensure sufficient language-switching. As documented by previous work (Meuter and Allport, 1999) the order of language blocks may impact the accuracy and reaction time of naming, a phenomenon that has been widely cited as an example of inducing short-term language regulation in the laboratory setting (Misra et al., 2012).

3.3.5 Translation Recognition Task – EEG

Study 2 examined bilinguals using ERP measurements collected during the Translation Recognition Task. Participants sat in a sound-attenuated booth to control for electrical noise, positioned approximately 60 cm from the stimulus presentation screen. Each EEG session lasted approximately 2 hours, during which EEG was recorded in the sound-attenuated room using a 32-channel active electrode system (LiveAmp, ActiCap, Brain Vision). Reaction times shorter than 200 ms or longer than 2000 ms were rejected. Additionally, scores exceeding 2.5 standard deviations above or below the mean value for each participant and each item were excluded.

To date, no studies to my knowledge have investigated how language brokers' representation and access to words in both their languages affect performance in a translation recognition task. This task involves presenting word pairs where one word is in the participant's L1 and the other in their L2. The participant's task is to determine whether the words in each pair are correct translations of each other. The critical trials in this task are those where the words in the pair are not correct translations, namely lexical form and semantic form distractors (see section “Revised Hierarchical Model and Language Brokering” for an explanation of the distractor types). Participants are presented with 480 translation pairs in English and Spanish. These were taken from a set of translation norms (Prior et al., 2007). Of these, translation pairs, 25% are correct

translation, 25% are incorrect translations unrelated to each other (unrelated control), 25% are incorrect lexical form translation distractors, and 25% are incorrect semantic form translation distractors (Ferré et al., 2023). Perhaps the biggest advantage of utilizing this task is that while translation production is a difficult task, translation recognition is a more accessible way to assess the lexicon of bilinguals across a wide range of proficiencies in their two languages. Here, this task is employed to explore how language brokers process and distinguish between translations and non- translations, providing insight into their lexical and semantic access across both languages.

3.4 Data Cleaning and Analysis

Translation Recognition Task: Responses are considered correct if the participant correctly identifies the translated word as matching or not matching the presented stimulus word. Incorrect responses are categorized as false positives (incorrectly matching a non-matching word) or false negatives (incorrectly identifying a matching word as non-matching). Reaction times are only considered for valid correct responses. Absolute outliers, with response times below 200 milliseconds or above 2000 milliseconds, are removed from the dataset. Additionally, any reaction time outside of 2.5 standard deviations above or below each participant's mean for each condition is excluded from analysis.

Behavioral data are analyzed using mixed-effects models with the lme4 software package (Bates et al., 2015) within the R programming environment (R Development Core Team, 2014). EEG data undergo analysis using repeated measures ANOVAs to assess variations in ERP mean amplitude across different conditions. Data for participants who drop out of the study or whose task battery is incomplete are excluded from analysis. For the ERP Translation Recognition

Task, I examine the amplitudes pre-established by Ma et al. (2017). I conduct ANOVAs in the N400 (300-500ms time window), and the LPC (500-700ms time window).

3.5 Predictions

Self-reports: I expect that all heritage bilinguals self-report that English (L2) is more dominant than Spanish (L1). However, I hypothesize that heritage bilinguals who have served as language brokers differ with respect to their maintenance of the L1 Spanish, such that they report more use of Spanish in their everyday lives. Consequently, I believe that habitual language brokers exhibit greater Spanish proficiency in comparison to their counterparts who did not serve as language brokers.

Production: For picture naming, I did not expect brokering experience to shape raw accuracy or speed within either language alone. Order effects, namely whether naming a language first or second within a block changes performance, are the more meaningful index here. If order effects tracked language dominance, they should have appeared most reliably when testing occurs in a participant's dominant language, and less reliably when testing language and dominance diverge. Given that pure language blocks isolates single-language lexical access, the more naturalistic insight to the cross-language competition that brokering is expected to affect may be present in the mixed naming block. Therefore, the main prediction was enhanced mixed block naming for more habitual brokers on the spectrum of brokering experiences.

Translation Recognition Behavioral: For translation recognition, the heritage bilingual group was expected to show the typical interference gradient across stimulus types (unrelated fastest, semantic-related slowest, form-related intermediate), reflecting lexical competition common to bilingual processing generally. Translation recognition is also the task that most directly mimics the core demand of brokering itself, extracting meaning from one language and

verifying it against the other, so I expected this task, more than verbal fluency or picture naming, to reveal brokering's influence. If brokering conferred a general translation-recognition advantage, brokering intensity should have improved model fit for reaction time overall, across all conditions but I did not expect this general pattern. Instead, I expected brokering's influence to be condition-specific, concentrated in the semantic-related condition, where cross-language conceptual competition is greatest, since language brokering should sharpen access to shared semantic-level representations across the two lexicons rather than general translation speed or accuracy. I further expected this semantic-specific effect to be driven by childhood brokering rather than adulthood brokering, following from the developmental timing of brokering onset.

Translation Recognition EEG: For the EEG analysis, participants were grouped into high- and low-brokering dichotomous groups. Responses to the language brokering questionnaire were aggregated separately across two points in the lifespan (childhood and adulthood) to calculate a total childhood brokering score and a total adulthood brokering score. A median split was then applied to each score to classify participants as high or low in childhood brokering and high or low in adulthood brokering. Because these classifications were performed separately for each developmental period, a participant's brokering group membership could differ across periods (e.g., high in childhood but low in adulthood, or vice versa); all four combinations of high/low childhood and adulthood status were possible.

In line with previous studies that explore this task, I predict that individuals with more language brokering experience (who have more integrated use of their two lexicons) reveal consistent patterns across brain and behavior with increased semantic distractor interference. I suspect that the semantic distractors modulate the N400 component (which has been used to investigate semantic processing; e.g., Ferré et al., 2023) and the lexical form distractors modulate

the LPC component (which has been investigated to show sensitivity to decision accuracy on semantic and lexical form distractors; e.g., Ma et al., 2017) differentially for individuals with higher brokering experience versus lower brokering experience.

3.6 Results

3.6.1 Participant Characteristics

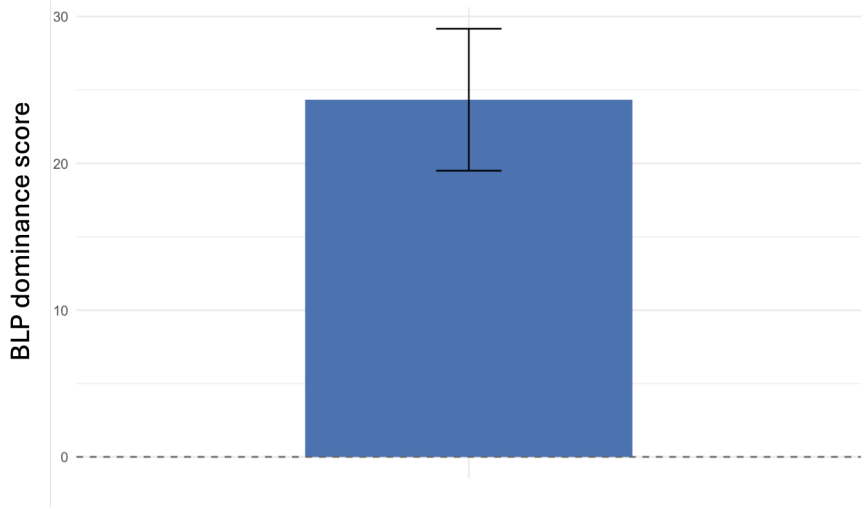
The Study 2 sample consisted of 49 Spanish-English heritage bilingual brokers (M = 20.57, SD = 3.25) recruited in Irvine, California (see table 5 and figure 10). The sample was

Table 5. *Study 2 Participant Characteristics*

	Spanish-English Bilinguals (EEG)
Age (yrs), *M (SD)*	20.57 (3.25)
Female, *n(%)*	36 (73%)
Male, *n(%)*	13 (27%)

Note. One participant's BLP data was not available.

Figure 10. *Bilingual Language Dominance in Spanish-English Heritage Bilinguals*



Note. Dominance scores were calculated from the Bilingual Language Profile (BLP) and reflect relative language dominance based on self-rated proficiency across English and Spanish. The average across participant resulted in the present positive values, which indicate greater English dominance, with larger values reflecting greater relative English dominance. Error bars represent ±1 standard error of the mean (SE).

predominantly female (n = 36, 73%), with male participants comprising the remainder (n = 13, 27%). BLP data were unavailable for one participant.

Participants' language history assessed via the BLP (presented in table 6) reflected an early-Spanish, later-English acquisition pattern typical of heritage bilingual populations. Spanish was acquired near birth (*M* = 0.33 years, *SD* = 1.23), while English was acquired later in early childhood (*M* = 4.14 years, *SD* = 2.78).

Table 6. *Study 2 Background Language Profile*

	Spanish-English Bilinguals (EEG)
English	
Age of Acquisition, M (SD)	4.14 (2.78)
Speaking, M (SD)	5.57 (0.61)
Reading, M (SD)	5.71 (0.54)
Writing, M (SD)	5.53 (0.74)
Understanding, M (SD)	5.80 (0.58)
Spanish	
Age of Acquisition, M (SD)	0.33 (1.23)
Speaking, M (SD)	4.57 (1.00)
Reading, M (SD)	5.00 (0.96)
Writing, M (SD)	4.24 (1.07)
Understanding, M (SD)	5.31 (0.85)

Despite this acquisition order, self-rated proficiency showed a different pattern: participants rated their English abilities as higher than their Spanish abilities across all four domains: speaking (English M = 5.57, SD = 0.61; Spanish M = 4.57, SD = 1.00), reading (English M = 5.71, SD = 0.54; Spanish M = 5.00, SD = 0.96), writing (English M = 5.53, SD = 0.74; Spanish M = 4.24, SD = 1.07), and understanding (English M = 5.80, SD = 0.58; Spanish M = 5.31, SD = 0.85). This dominance profile of acquiring Spanish first but rating English as the stronger language is consistent with a heritage language pattern in which the societal/schooling

language (English) comes to be the dominant language despite later acquisition, and it foreshadows the dominance reversal pattern observed later in the behavioral data.

Language Brokering Characteristics

Participants' brokering histories were characterized using the Language Brokering Questionnaire (LBQ), which captures five dimensions of brokering experience: the number of people brokered

Table 7*. Study 2 Language Brokering Characteristics*

	Spanish-English Bilinguals (EEG)
People brokered for	
Childhood	16.57 (4.07)
Adulthood	15.37 (5.50)
Speech brokering	
Childhood	29.59 (9.16)
Adulthood	25.42 (11.20)
Text brokering	
Childhood	29.43 (10.00)
Adulthood	25.37 (11.05)
Brokering frequency	
Childhood	75.59 (21.40)
Adulthood	66.16 (25.41)
Attitudes toward brokering	
Childhood	81.23 (10.25)
Adulthood	72.55 (13.40)
Total language brokering	
Childhood	156.82 (25.78)
Adulthood	138.71 (35.82)
Overall	296.68 (53.52)

Note. Language brokering dimensions reflect (a) people brokered for, or the individuals for whom participants provided language brokering; (b) speech brokering, or brokering conducted through spoken communication; (c) text brokering, or brokering conducted through written or text-based communication; (d) brokering frequency, or how often participants engaged in language brokering; and (e) attitudes toward language brokering, or participants' perceptions and feelings about their brokering experiences. Childhood and adulthood scores reflect language brokering experiences during the respective developmental periods.

for, speech brokering, text brokering, brokering frequency, and attitudes toward brokering separately for childhood and adulthood. Results are shown in table 7.

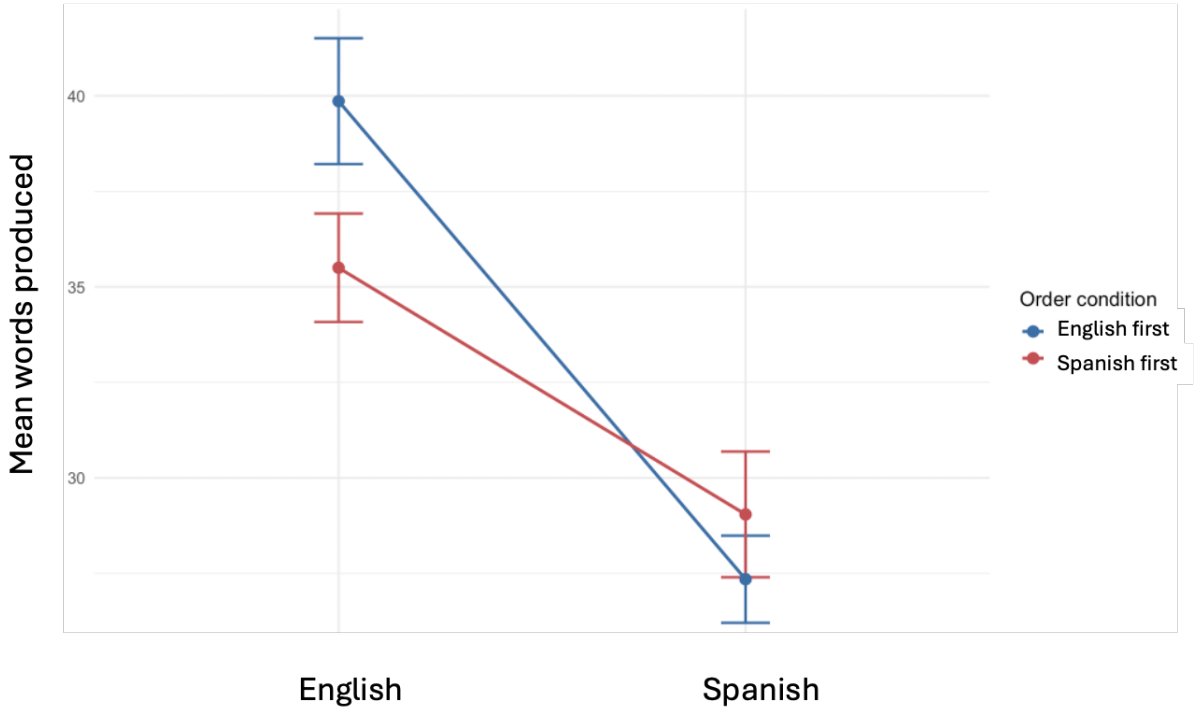
Across every dimension, brokering scores were higher in childhood than in adulthood. Participants reported brokering for more people during childhood (M = 16.57, SD = 4.07) than adulthood (M = 15.37, SD = 5.50) and engaged in more speech brokering (childhood M = 29.59, SD = 9.16; adulthood M = 25.42, SD = 11.20) and text brokering (childhood M = 29.43, SD = 10.00; adulthood M = 25.37, SD = 11.05) during childhood as well. Brokering frequency showed the same pattern (childhood M = 75.59, SD = 21.40; adulthood M = 66.16, SD = 25.41), as did attitudes toward brokering, which were more positive in childhood (M = 81.23, SD = 10.25) than adulthood (M = 72.55, SD = 13.40).

This convergence produced higher total brokering scores in childhood (M = 156.82, SD = 25.78) than adulthood (M = 138.71, SD = 35.82), with an overall composite score of M = 296.68 (SD = 53.52) across both developmental periods. The consistency of this childhood-over-adulthood pattern across all five dimensions suggests that brokering was a more intensive, more frequent and more positively experienced earlier in development. This is a pattern that motivates treating childhood and adulthood brokering as separable rather than interchangeable predictors in subsequent analyses.

3.6.2 Verbal Fluency

A linear mixed-effects model was fit to verbal fluency scores with fixed effects of Language (English vs. Spanish), Order of Naming (English-first vs. Spanish-first), and their interaction, and a random intercept for participant (N = 53). Results are presented in Figure 11.

Figure 11. *Language Order Effects on Verbal Fluency Performance in Spanish-English Heritage Bilinguals*



Note. Mean number of words produced on the verbal fluency task is shown by language and naming order (English-first vs. Spanish-first). Error bars represent ±1 standard error of the mean (SE).

Language main effect

There was a large, highly significant main effect of Language, $F(1, 51) = 69.59$, $p < .001$. Collapsing across order, participants produced significantly more words in English ($M = 39.9$, $SE = 1.41$, English-first condition) than in Spanish ($M = 27.3$, $SE = 1.41$), confirmed by the overall paired t test as well, $t(52) = 8.17$, $p < .001$, $d = 1.12$, 95% CI [0.77, 1.46]. This indicates clear English-dominant fluency in this bilingual sample.

Order main effect

The main effect of order of naming was not significant, $F(1, 51) = 0.58$, $p = .452$, indicating no overall difference in total fluency output depending on which language was produced first.

Language × Order interaction

This interaction was significant, $F(1, 51) = 7.10$, $p = .010$: the order effect differed by language. Producing Spanish first narrowed the usual English advantage (English–heritage difference: 6.46 words, $p < .001$), compared to producing English first (12.52 words, $p < .001$). In other words, naming in Spanish, the less dominant language, first causes the dominant language English to have less words produced in a verbal fluency task.

Order effect within each language

Follow-up models testing the order effect separately for each language clarified where this interaction originated. For English fluency, there was a marginal effect of order, $F(1, 51) = 3.84$, $p = .055$, so English fluency was somewhat higher when English was named first ($M = 39.9$, $SE = 1.50$) than when it was named second, after Spanish ($M = 35.5$, $SE = 1.65$). For Spanish fluency, there was no effect of order, $F(1, 51) = 0.76$, $p = .389$ (English-first $M = 27.3$, $SE = 1.31$; Spanish-first $M = 29.0$, $SE = 1.44$). This effect is similar to what has been seen in past literature where the dominant language suffers the impact of the regulation due to being named after the non-dominant language.

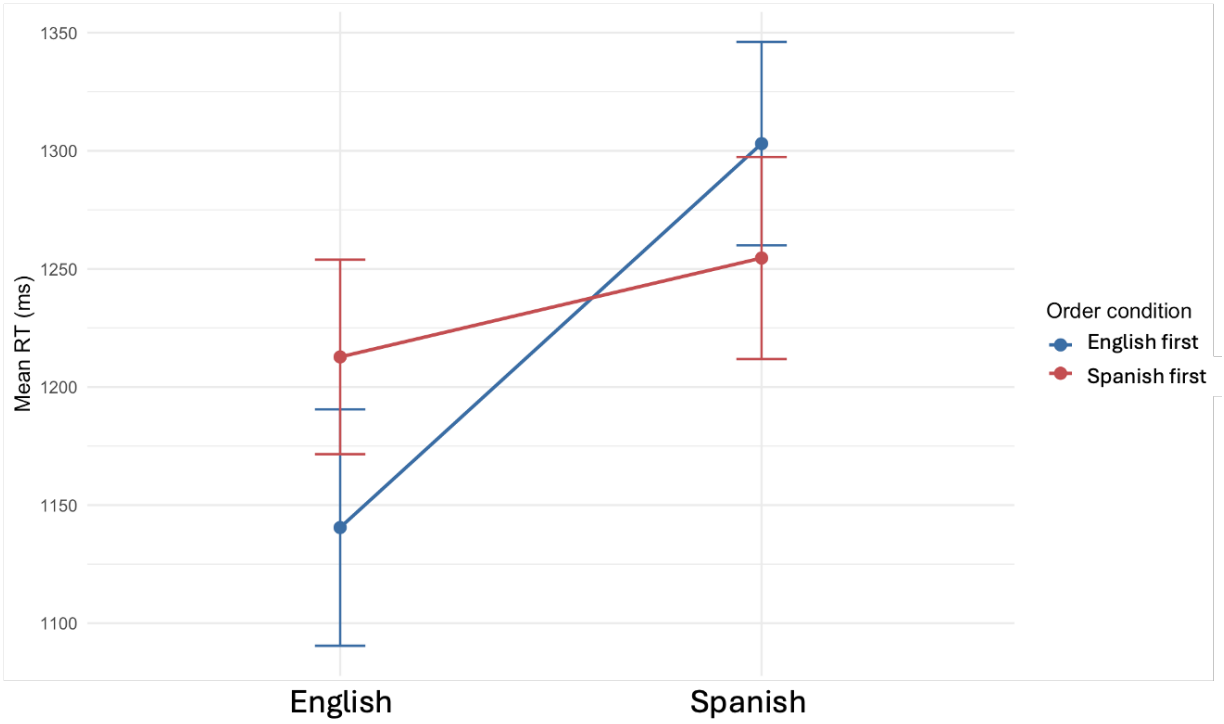
Summary

Spanish-English bilinguals in this sample showed markedly greater fluency in English than in Spanish overall. This was consistent with an English-dominant profile similar to the Spanish-English broker group in Study 1. This English advantage was not fixed, however: it was significantly attenuated when Spanish was elicited first, driven primarily by a (marginal) drop in English fluency when English followed Spanish, rather than by any boost to Spanish fluency from going first. Spanish fluency itself was stable regardless of naming order.

Picture naming provides a converging, more tightly timed test of this same order-dependent dominance pattern, this time measured directly in reaction time rather than output count.

3.6.3 Picture Naming Reaction Time

Figure 12. *Picture-Naming Reaction Time by Language and Order Condition*



Notes. Mean reaction time (RT; ms) for correct picture-naming trials is shown by language and order condition (English-first vs. Spanish-first). Reaction times were cleaned prior to analysis. Error bars represent ±1 standard error of the mean (SE).

A linear mixed-effects model was fit to picture-naming reaction time (correct trials only, cleaned) with fixed effects of language (English vs. Spanish), order of naming (English-first vs. Spanish-first), and their interaction, and a random intercept for participant (N = 53). Results are shown in Figure 12.

Language main effect.

There was a significant main effect of Language, $F(1, 48.69) = 12.04$, $p = .001$. Collapsing across order, participants were faster to name pictures in English (M = 1,141 ms, English-first condition) than in Spanish (M = 1,304 ms), confirmed by the overall paired t test as well, $t(51) = -3.66$, $p = .001$, $d = -0.51$, 95% CI [-0.79, -0.22]. This is a medium effect, indicating a clear English speed advantage in this sample overall, which aligns with their dominance in the societal language of English.

Order main effect.

The main effect of Order of Naming was not significant, $F(1, 49.24) = 0.07$, $p = .787$, indicating no overall difference in reaction time depending on which language was produced first.

Language × Order interaction.

This interaction approached but did not reach conventional significance, $F(1, 48.69) = 3.69$, $p = .061$. Simple-effects decomposition showed that the English-speed advantage was substantial when English was named first (English-first: English minus heritage = -163.5 ms, $SE = 42.1$, $t(50.0) = -3.88$, $p < .001$) but shrank to non-significance when Spanish was named first (heritage-first: English minus heritage = -46.9 ms, $SE = 43.6$, $t(50.7) = -1.08$, $p = .287$). In other

words, naming Spanish first largely closed the English-speed gap — a pattern that echoes the language × order interaction found in Study 2's verbal fluency data.

Order effect within each language.

Follow-up models testing the order effect separately for each language showed no significant order effect for either English reaction time, $F(1, 51) = 1.28$, $p = .264$, $\eta^2 = .02$ (English-first $M = 1{,}141$, heritage-first $M = 1{,}214$), or heritage reaction time, $F(1, 50) = 0.80$, $p = .374$, $\eta^2 = .02$ (English-first $M = 1{,}304$, heritage-first $M = 1{,}250$). Neither reached significance on its own, though both trended in the direction consistent with the interaction: English became somewhat slower when named second, and heritage-language naming became somewhat faster when named second.

Brokering effects on picture naming (pure block)

To test whether brokering experience moderates picture naming performance independent of the switching demands present in the mixed block, a set of baseline, additive, and interaction models was fit to pure-block RT.

Childhood brokering

For childhood brokering (n = 40), adding brokering to the baseline model did not improve fit, $\chi^2(1) = 1.47$, $p = .225$, nor did the interaction model improve on the additive model, $\chi^2(1) = 0.14$, $p = .706$, or on baseline, $\chi^2(2) = 1.61$, $p = .446$; the baseline model had the lowest AIC (31509.19) and BIC (31531.83).

Adulthood brokering

For adulthood brokering (n = 35), the pattern was identical: the additive model did not improve on baseline, $\chi^2(1) = 0.02$, $p = .875$, and the interaction model did not improve on the additive model, $\chi^2(1) = 1.67$, $p = .196$, or on baseline, $\chi^2(2) = 1.70$, $p = .428$, with baseline again preferred by AIC (28626.48) and BIC (28648.73). Brokering experience across the lifespan did not significantly modulate picture naming reaction time in the pure block, reinforcing that picture naming is not as sensitive to brokering impacts.

Summary

As with verbal fluency in Study 2, Spanish-English bilinguals showed an overall English-speed advantage in picture naming, and this advantage was order-dependent: it was strong and significant when English was produced first but attenuated to non-significance when Spanish was produced first.

This is consistent with an interference account in which producing the dominant language (English) is more costly when it follows recent use of the non-dominant language. This is the same qualitative pattern observed in the verbal fluency data, now replicated in a separate task (picture naming) within Study 2.

Brokering itself, however, showed no relationship to picture naming RT in either block type, mixed or pure, and regardless of whether brokering was measured in childhood or adulthood. This null result stands in contrast to the order-dependent dominance effects above and is consistent with the broader task-sensitivity gradient described across the dissertation: brokering effects emerge for translation recognition, are attenuated for verbal fluency, and are absent for picture naming.

Brokering effects on picture naming (mixed block)

Analyses were restricted to trials from mixed-language naming blocks, in which participants alternated between English and Spanish picture-naming within the same block. Because language regulation demands are heightened when speakers must switch between languages on a trial-by-trial basis, mixed-block RT was treated as a context in which brokering-related control experience might be most likely to surface.

Childhood brokering

Adding childhood brokering to the baseline model (language only) did not significantly improve model fit, $\chi^2(1) = 3.49$, $p = .062$, but it approached the conventional metric for significance and showed a modest AIC improvement over baseline (34,105.8 vs. 34,107.3). The interaction model (language × childhood brokering) did not improve on the additive model, $\chi^2(1) = 2.22$, $p = .137$, and the comparison against baseline also fell short of significance, $\chi^2(2) = 5.70$, $p = .058$, though again in the same marginal range. AIC continued to favor the more complex models slightly (interaction: 34,105.6), but BIC favored the baseline model at every step (baseline: 34,130.2; additive: 34,134.5; interaction: 34,140.0). Taken together, childhood brokering showed a small, marginal association with mixed-block naming reaction time that did not reach significance and did not clearly interact with language.

Adulthood brokering

Neither the additive model, $\chi^2(1) = 0.40$, $p = .529$, nor the interaction model (vs. additive: $\chi^2(1) = 0.03$, $p = .859$; vs. baseline: $\chi^2(2) = 0.43$, $p = .807$) improved on the baseline model, and AIC/BIC favored the baseline model at every comparison. Adulthood brokering was therefore not associated with mixed-block picture-naming reaction time, whether tested additively or interactively.

Summary

In mixed naming blocks, childhood brokering showed a marginal, non-significant additive association with naming reaction time ($p = .062$) that did not reach significance and showed no interaction with language, while adulthood brokering showed no relationship to reaction time in this context at all. These results suggest that any influence of brokering experience on mixed-block picture-naming reaction time is at best a general trend rather than a reliable effect and offer no evidence that brokering selectively alters the language-specific cost of naming under mixed-language demands as previously predicted.

3.6.4 Picture Naming Accuracy

Mixed Block

Childhood Brokering (n = 42)

Childhood brokering on its own did not predict overall accuracy, $b = 0.05$, $SE = 0.14$, $p = .721$. But it did significantly change the size of the English-heritage accuracy gap: adding the brokering-by-language interaction improved the model over baseline, $\chi^2(2) = 30.38$, $p < .0001$, and the interaction itself was significant and negative, $b = -0.35$, $SE = 0.07$, $p < .0001$. Therefore, the more someone brokered as a child, the smaller their English-accuracy advantage was: their heritage-language accuracy came closer to matching their English accuracy. People with little or no childhood brokering showed the biggest gap favoring English; people with a lot of childhood brokering showed close to no gap at all.

Adulthood Brokering (n = 36)

Adulthood brokering had no effect here in either direction. Adding it to the model didn't help, $\chi^2(1) = 0.52$, $p = .470$, and it didn't change the size of the language gap either, $\chi^2(1) = 0.89$, $p = .345$. In the mixed block, how much someone broker as an adult made no detectable difference to picture naming accuracy.

Pure Block

Childhood Brokering (n = 41)

The pattern from the mixed block repeated almost exactly. No simple effect of childhood brokering on overall accuracy, $b = 0.11$, $SE = 0.21$, $p = .615$, but a significant narrowing of the English-heritage gap, $\chi^2(2) = 27.71$, $p < .0001$, interaction $b = -0.36$, $SE = 0.07$, $p < .0001$. Again here, the more childhood brokering experience led to the smaller the English advantage.

Adulthood Brokering (n = 36)

This is where adulthood brokering finally showed an effect, and it is a bit more complicated than childhood brokering's effect. Adding adulthood brokering improved the model over baseline, $\chi^2(1) = 8.45$, $p = .004$, and adding the interaction improved it further, $\chi^2(1) = 9.91$, $p = .002$. Two things were going on at once: overall accuracy dropped as adult brokering went up (a main effect): $b = -0.66$, $SE = 0.20$, $p = .001$. More adult brokering was also associated with lower accuracy across both languages. On top of that, the English-heritage gap also narrowed with more adult brokering: $b = -0.26$, $SE = 0.08$, $p = .0015$. This has the same directional pattern as childhood brokering with more brokering, smaller English advantage. However, here it came bundled with a general accuracy cost that childhood brokering didn't show.

Summary

Childhood brokering was consistently linked to a smaller English-heritage accuracy gap, and this held in both mixed and pure blocks such that the more someone brokered growing up, the closer their heritage-language accuracy came to their English accuracy, with no cost to overall accuracy. Adulthood brokering showed no effect in the mixed block, but in the pure block it produced the same narrowing of the gap as childhood brokering, plus an additional overall accuracy decline not seen with childhood brokering. In other words, brokering experience (especially in childhood) seems to shrink the accuracy and speed advantage of the dominant language English while adulthood brokering may come with a broader accuracy trade-off that childhood brokering does not.

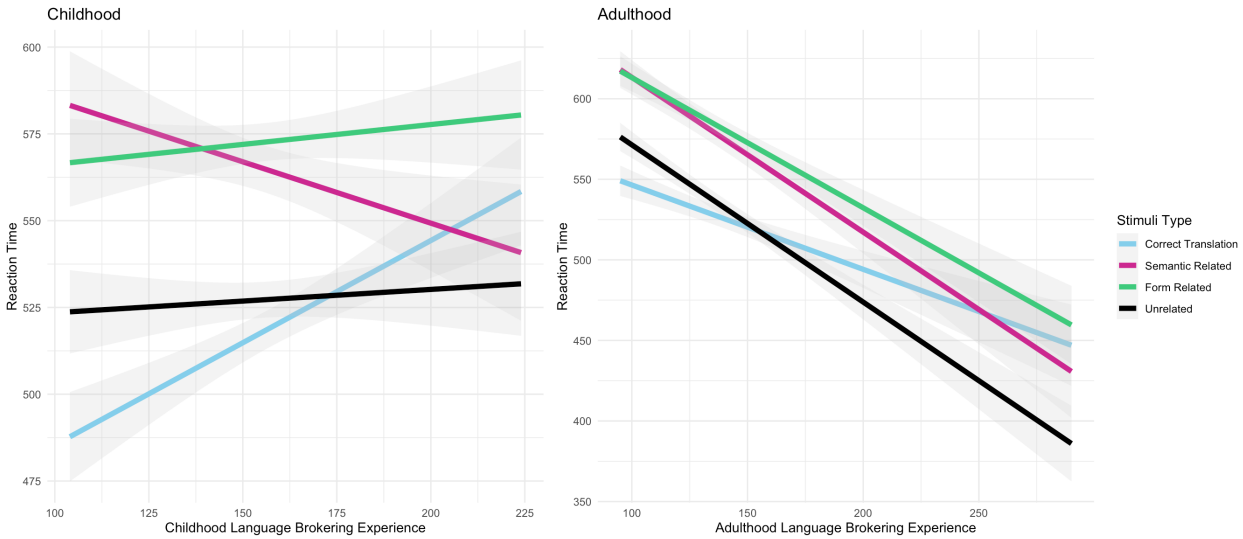
With this order-dependent dominance pattern established in both production tasks, I turn next to the translation recognition task, which allows brokering experience itself, rather than language dominance, to be tested directly against reaction time, and which forms the behavioral half of the brain-behavior comparison at the center of Study 2.

3.6.5 Translation Recognition — Behavioral

Reaction Time: Stimulus Type

A linear mixed-effects model was fit to translation recognition reaction times (correct trials only, cleaned; $N = 49$ participants) with a fixed effect of stimulus type (unrelated, form-related, semantic-related) and a random intercept for participant (see Figure 13).

Figure 13. *Translation Recognition Reaction Time by Brokering Experience*



There was a significant main effect of stimulus type, $F(2, 13000) = 207.92$, $p < .001$. Pairwise comparisons showed that all three conditions differed significantly from one another: participants were fastest on unrelated trials ($M = 547$ ms), significantly slower on form-related trials ($M = 591$ ms; unrelated vs. form-related: $b = -43.6$, $SE = 2.80$, $z = -15.59$, $p < .001$), and slowest on semantic-related trials ($M = 603$ ms; unrelated vs. semantic-related: $b = -56.1$, $SE = 2.99$, $z = -18.76$, $p < .001$). Semantic-related trials were also significantly slower than form-related trials, $b = -12.5$, $SE = 3.04$, $z = -4.10$, $p < .001$.

Summary

Study 2 replicates the interference effects that were seen in Study 1. Translation recognition reaction time increases as distractor overlap with the target becomes more semantically related, with unrelated distractors producing the fastest responses and semantic-related distractors the slowest, and form-related trials falling in between. This ordering was

consistent, and all three pairwise differences were significant, indicating a robust condition effect in this single group of heritage bilinguals.

Reaction Time and Language Brokering: Childhood vs. Adulthood

Childhood brokering

Model comparison showed no evidence that childhood brokering improves translation recognition reaction time predictions. Adding it as an additive predictor did not improve fit, $\chi^2(1) = 0.25$, $p = .615$, and allowing it to interact with stimulus type also did not improve fit, $\chi^2(2) = 4.52$, $p = .105$ (vs. additive) and $\chi^2(3) = 4.77$, $p = .189$ (vs. baseline). Simple slopes were non-significant across all three stimulus types (all ps $\geq .53$).

Adulthood brokering

Adulthood brokering showed a more suggestive, but still non-significant pattern. The additive model trended toward improving fit, $\chi^2(1) = 3.03$, $p = .082$, and the interactive model showed a similar trend, $\chi^2(2) = 5.47$, $p = .065$ (vs. additive). The overall test against baseline reached significance, $\chi^2(3) = 8.50$, $p = .037$, and AIC favored the interactive model (119,360.3 vs. 119,362.8 for baseline). However, simple slopes were consistently negative but not significant at any stimulus type (unrelated: $b = -0.98$, $p = .08$; form-related: $b = -0.81$, $p = .14$; semantic-related: $b = -1.01$, $p = .07$), therefore more brokering experience trending toward faster reaction time, but not significantly.

Summary

Unlike Study 1, neither childhood nor adulthood brokering showed a statistically reliable relationship with translation recognition reaction time in Study 2. Childhood brokering showed

essentially no signal at all. Adulthood brokering showed a consistent trend (faster reaction time with more adulthood brokering, across all three stimulus types) that approached but did not reach significance).

This behavioral null is the immediate motivation for the ERP analyses that follow: if brokering's influence on lexical and semantic access is present but too subtle to see in a reaction time measure, it may still be visible in the finer-grained time course captured by the N400 and LPC.

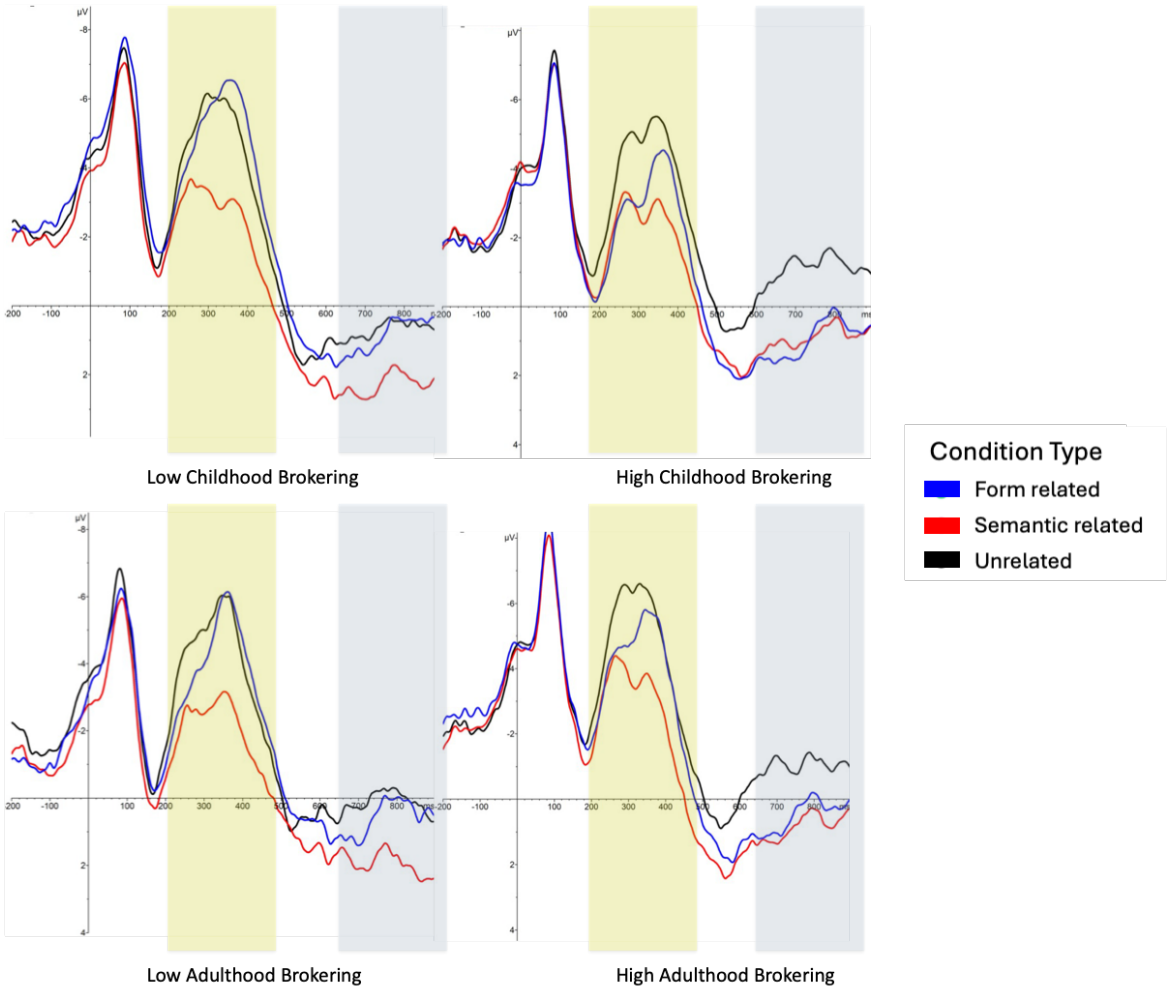
3.6.6 Translation Recognition — EEG

Across the Study 2 analyses, language brokering experience is modeled as a continuous predictor, consistent with the treatment of brokering used across this dissertation rather than as a dichotomous high/low grouping. For the ERP grand-average waveform visualizations specifically, participants are divided via median split into higher- and lower-brokering subgroups, since continuous experience is difficult to depict visually in ERP plots; this visualization choice reflects a constraint on plotting but not in the analytical approach. Language brokering is included in the models that follow as a continuous variable.

For both the N400 and LPC, linear mixed-effects models were fit predicting mean amplitude from condition (unrelated, form, semantic), ROI (nine regions crossing Left/Midline/Right by Frontal/Central/Posterior), group (brokering experience with a high vs. low median split), and the group × condition interaction, with a by-participant random intercept. Condition was referenced to unrelated; group was referenced to Low; ROI was referenced to LeftCentral. The ROIs were established a priori per pertinent previous literature by Ferre et al.,

(2023). Models were fit separately for childhood and adulthood brokering experience. Results for all time periods are presented in figure 14.

Figure 14. *ERP Waveforms*



Note. Black line is the unrelated baseline. Blue is semantic related distractor. Red line is form related distractor.

Method – ROI & Analysis Logic

Nine ROIs (Left/Midline/Right × Frontal/Central/Posterior) were defined by grouping the 32 electrodes into a 3×3 grid. These ROIs were consistent with electrode groupings used in prior translation recognition ERP work (Ferré et al., 2023; Guo et al., 2012), allowing both components' (N400 and LPC) to be tested within a single framework.

N400 Childhood Brokering

Semantic distractors elicited significantly more positive amplitude than unrelated, b = 2.41, SE = 0.68, t(356.50) = 3.57, p < .001; form was marginal, p = .096. Group and both group × condition interactions were non-significant (ps > .20). ROI showed significant topographic variation (five of eight regions differed from reference, ps < .02). The three-way group × condition × ROI interaction was significant for form at most regions (ps < .05) but non-significant for semantic everywhere (ps > .13). The semantic N400 was present across the sample but showed no evidence of modulation by childhood brokering status, while form processing showed an effect that varied by group and ROI.

N400 Adulthood Brokering

The semantic effect was marginal, b = 1.35, SE = 0.81, t(281.85) = 1.67, p = .097; form was not significant. Group × form reached significance, b = 3.60, SE = 1.79, t(58.45) = 2.01, p = .049. ROI variation was more limited (MidlineCentral only, p < .001). The three-way interaction was significant for form across most ROIs (ps < .03) but non-significant for Semantic everywhere (ps > .13). Unlike childhood brokering, adulthood brokering showed a significant group × form interaction, but no reliable modulation of the semantic N400, suggesting that any adulthood brokering effects are limited to form level processing and not semantic interference resolution.

LPC Childhood Brokering

Semantic distractors showed significantly more positive amplitude than unrelated, b = 1.90, SE = 0.66, t(237.11) = 2.90, p = .004; form was marginal (p = .060). Group and both group × condition interactions were non-significant (ps > .30). ROI effects were significant at three

regions, strongest at MidlinePosterior, b = 3.04, t(3150) = 5.63, p < .001. The three-way interaction was significant for form at most regions (ps < .05) but not for Semantic anywhere (ps > .06). The LPC showed a reliable semantic effect that (like the N400) was unaffected by childhood brokering status overall, but form related processing again showed brokering related ROI specificity without a shift in the effect's magnitude.

LPC Adulthood Brokering

Neither form nor semantic differed from unrelated (ps > .31). Group × Form was marginal, b = 3.51, SE = 1.82, t(51.40) = 1.93, p = .059. Several Group × ROI interactions were significant here uniquely (ps < .03), suggesting baseline topographic differences by adulthood brokering group. The three-way interaction was significant for Form across most ROIs (ps < .03) but non-significant for Semantic everywhere (ps > .10). Therefore, adulthood brokering showed no significant condition effects, but did show topographic differences between groups at baseline, plus the recurring form specific three-way interaction.

Summary

Language brokering experience didn't change how the brain responded to semantically related distractors. This held true whether we looked at childhood or adulthood brokering. It also held true across both time windows we measured (N400 and LPC). In other words, bilinguals across a spectrum of brokering experiences processed meaning-related interference the same way at the neural level.

Form related distractors told a different story. These are words that look or sound similar but aren't related in meaning. Here, brokering experience did make a difference, especially brokering that started in adulthood. For childhood brokering, the difference wasn't in how

strongly the brain responded overall, but in where on the scalp that response showed up. For adulthood brokering, the picture was a bit more layered such that the N400 stage, brokering group changed both the strength of the form response and the scalp distribution, while at the LPC stage, adulthood brokering groups differed in scalp topography even independent of the distractor condition itself.

This distinction shows the analysis was sensitive enough to detect real brokering related differences when they existed. We saw that for the form related responses, and in some cases for the underlying neural organization more broadly. This furthers the argument that brokering has a targeted effect. It seems to shape how the brain handles surface-level word overlap and in the case of adulthood brokering, it also seems to change some baseline patterns in the brain's activity.

3.7 Interim Discussion

The behavioral results from Study 2 triangulate the patterns established in Study 1's Spanish-English broker group, while the childhood/adulthood brokering analyses tell a different story than they did in Study 1.

Order-Dependent Dominance: Replicating and Extending Study 1

As in Study 1's Spanish-English broker group, participants here showed clear English dominance in both verbal fluency and picture naming. Critically, this advantage was order-dependent in both tasks: it was strong when English was produced first and was attenuated (verbal fluency) or reduced to non-significance (picture naming) when Spanish was produced first. This is consistent with the language-regulation account developed in Chapter 2 that producing the non-dominant language first appears to pre-activate it and reduce the interference

it would otherwise generate when producing the dominant language second. This goes back to the dual-language activation and regulation framework introduced in Chapter 1. The translation recognition interference gradient (unrelated fastest, semantic-related slowest) also replicated from Study 1, reinforcing that this interference gradient is a consistent feature of translation recognition.

C*hildhood versus Adulthood Brokering: A Behavioral Null, and Why ERPs May Matter*

Unlike Study 1, neither childhood nor adulthood brokering reliably predicted translation recognition reaction time in Study 2, although adulthood brokering showed a non-significant trend toward faster reaction time across all three stimulus types. Several features of Study 2's design may contribute to this behavioral null. Study 2 samples a single population of Spanish-English brokers rather than comparing across groups, which removes the between-group comparison that helped isolate the childhood-brokering effect in Study 1. Behavioral reaction time in a single-group sample as opposed to group comparisons may limit the way we can capture a process that may unfold in more than one stage.

This last point was the central motivation for pairing behavioral and electrophysiological measures in Study 2. Prior work has shown that ERPs can reveal processing differences that are not visible in accuracy or reaction time alone (Grey et al., 2018; Thierry & Wu, 2007) because bilinguals or conditions that look equivalent behaviorally can diverge in the time course of lexical and semantic access captured by components like the N400 and LPC. If childhood brokering shapes the strength of shared lexical-conceptual links, as proposed in Chapter 2's discussion, that influence might have been expected to surface as a modulation of N400 amplitude to semantic distractors specifically, or in LPC amplitude during the later decision-monitoring stage of rejecting a distractor.

Across every way I tested it, the same pattern held: brokering had no effect on how the brain processed semantic distractors. This was true for childhood and adulthood brokering, and for both the N400 and LPC windows. Form-related distractors were different. Brokering didn't change the overall strength of the form response, but it did change where on the scalp that response appeared. This group × condition × ROI interaction was significant for form across most regions in all four models. Adulthood brokering also showed a direct group × form interaction in both time windows (N400: $p = .049$; LPC: $p = .059$), plus topographic differences between adulthood-brokering groups that didn't depend on condition at all ($ps < .03$).

A few caveats on the semantic null. Splitting by brokering group for visualization roughly halved the sample per condition, and even though the actual models used continuous scores, the overall sample size still limits power to detect a brokering effect on semantic processing specifically (despite the study being in line with sample size of similar studies). There is also a narrower spread of brokering scores is the single sample, which means less variance for an effect to show up in. That said, the form results show the analysis was not simply underpowered. It picked up a real effect where one existed, just not for semantic processing.

Overall, Study 2 does not replicate the childhood-specific, semantic-specific effect I found behaviorally in Study 1. Semantic processing was robust across the whole sample here, with no sign that brokering experience modulates it. This fits the interactional-context account in that if the Study 1 effect depends on the specific between-group comparison there rather than a general property of brokering, then not finding it in a single-population EEG sample isn't a contradiction. Study 2 also adds a consistent brokering-related effect on the topography of form processing, strongest for adulthood brokering but present for childhood too. Since this wasn't

part of my original framework, I am treating it as exploratory, but its consistency makes it worth following up on directly in future directions.

Chapter 4: General Discussion

4.1 Synthesis Across Studies

The central theoretical prediction of the present dissertation centered on the idea that the consequences of language brokering would not appear uniform across tasks; this prediction was confirmed. Translation recognition, which is the task most directly related to the act of brokering itself, was the only task on which brokering experience left a significant impact. The consequence, or in this case benefit, of brokering was shown through interactions with semantic distractors (not lexical form), and this was consistent with the prediction that brokering may strengthen mediation between translations equivalents as opposed to general lexical access. Picture naming, which does not require cross-language mediation on any given trial, showed no brokering-related effects in either study. Verbal fluency played the predicted intermediate position: group differences emerged but did not resolve into a clean brokering advantage. Instead, the impacts on verbal fluency were better explained by the order in which languages were produced than by brokering experience per se. The patterns that emerged in this dissertation do not fit an account of language brokering conferring a general bilingual processing advantage. Rather, the data presented here support a more nuanced, task-specific/domain-specific account of the impacts of brokering on a bilingual's language processing.

Considered separately, Study 1 and Study 2 each tell a partial story about language brokering. Study 1's cross-cultural, group-comparison design shows that brokering does not confer a uniform advantage relative to non-brokering and at the same time, that specific dynamics of the interactional context (including code-switching tendencies, and language-pair

typology) may shape translation recognition performance differently than brokering status does. Following the predicted trends, study 1 also demonstrated that when brokering does leave a significant effect on reaction time, it does so specifically through childhood brokering's interaction with semantic distractors, not through adulthood brokering and not as a general main effect.

Study 2's continuous, single-population, EEG design shows that this same childhood/adulthood asymmetry does not appear consistently in behavior when brokering experience is modeled continuously. ERPs to the same translation recognition task told a different, more targeted story: the semantic N400 effect was robust across the sample, but neither childhood nor adulthood brokering moderated N400 or LPC amplitude to semantic distractors at any level of analysis. Brokering experience did, however, moderate the scalp topography of the response to form-related distractors; this pattern was not evident in behavior in either study, and most consistent for adulthood brokering. Rather than confirming the semantic-mediation account predicted in Chapter 2, the neural data show a more nuanced picture that the ways brokering may manifest behaviorally versus neurally differ. Overall, results revealed that childhood brokering shows essentially no relationship with reaction time in Study 2, while adulthood brokering shows a non-significant trend toward faster responding that was entirely absent in Study 1.

These results point to a common underlying claim examined through two different lenses. Study 1's between-group design is better suited to detect effects that depend on comparing brokers to a matched group of non-brokers, and it is in this comparison that childhood brokering's interaction with semantic-distractor interference emerged. Study 2's within-broker, continuous design removes that comparison group entirely, sampling only individuals who have brokered to some degree; if childhood brokering's behavioral signature depends on the presence of a non-broker

baseline, restricting the sample to brokers alone could attenuate or eliminate it in reaction time, independent of whether the underlying neural or cognitive change is still present. This is the situation in which EEG measures can best add information that reaction time cannot do on its own (Grey et al., 2018; Thierry & Wu, 2007).

A second pattern also points to interactional context rather than brokering itself. In Study 1, Mandarin-English heritage bilinguals were fastest, Mexican sequential bilinguals were in the middle, and Spanish-English heritage bilinguals were slowest. Code-switching frequency helps explain this better than brokering status does. The two heritage groups differed significantly in how often they code-switched, based on the social network questionnaire. Spanish-English bilinguals switched more than Mandarin-English bilinguals. Under adaptive control theory (Green & Abutalebi, 2013), frequent code-switching may shift how bilinguals regulate their two languages. This shift in regulatory strategy, and not differential activation per se, could explain why the Spanish-English group was slower on the translation task, though this remains one hypothesis. It also fits the Mexican group's middle position, since they come from a more Spanish-dominant setting with less back-and-forth switching than the California broker communities.

This points to an important distinction: code-switching and brokering are not the same thing. Both heritage groups had brokering experience, but only code-switching frequency lined up with the speed differences. Separately, it was childhood brokering, not adulthood brokering, that predicted more interference on the translation task. So two different patterns showed up for two different variables. This suggests code-switching habits and brokering experience work through different mechanisms, not that one is just standing in for the other.

Finally, both studies converge on a shared account of language regulation as context-dependent (Green & Abutalebi, 2013; Beatty-Martínez et al., 2020). The order effects observed in verbal fluency and picture naming in both Study 1 and Study 2, where producing the non-dominant language first reduced or eliminated the dominant language's usual speed advantage, replicated across two independent samples and two production tasks. This reinforced that even within a single testing session, momentary language regulation is highly sensitive to what was produced immediately before. This sensitivity to recent linguistic context is consistent with this dissertation's broader claim that bilingual language processing, including whatever role brokering plays in shaping it, cannot be fully understood by treating brokering as a static trait. Language brokering must instead be understood as one factor, alongside interactional context, language-pair, and linguistic history, that shape language processing dynamically.

A finding that warrants discussion across both studies was that heritage speakers consistently performed with slower reaction times on the picture naming and translation recognition tasks. One hypothesis that is proposed for this pattern in the bilingualism literature is the frequency-lag hypothesis. According to this hypothesis, because heritage speakers generally receive less overall input in their heritage language relative to their dominant language the lexical representations accessed during retrieval are less frequently activated and are consequently retrieved more slowly (Gollan et al., 2008; Sullivan, Poarch, & Bialystok, 2018). Under this account, slower reaction times reflect a straightforward consequence of reduced or less consistent exposure where we observe weaker activation strength for heritage language items relative to items in the dominant language. It is worth noting that support for this account is mixed with a recent study finding that order and frequency effects patterned differently than the frequency-lag account would predict (Mizrahi, Wixted, & Gollan, 2021).

However, viewing the slowed heritage bilingual responses through a deficit lens may not fully capture what is happening during heritage language retrieval. The concept of desirable difficulty (1994; Bjork & Bjork, 2011) is a related account that may explain the patterns that emerged here; it posits that there is a certain level of difficulty which humans encounter that may in turn produce more favorable outcomes. Through the desirable difficulties account, the conditions of retrieving a heritage language which is less frequently activated, may produce more varied routes for lexical retrieval than effortless, highly frequently activated dominant language retrieval would. Under this view, the slower retrieval observed in heritage speakers may not be an indicator of a weaker lexical system, but rather it may reflect a more effortful retrieval process that through repeated use, is actively building more resilient representations (even though these remain slower in the moment). This reframing is particularly relevant to the present dissertation because language brokering may be one of the very experiences that generates this kind of effortful, desirably difficult retrieval: brokering routinely requires heritage speakers to retrieve and produce translation equivalents on demand, often under real-time social pressure, and frequently for lower-frequency or domain-specific vocabulary encountered outside the home. Rather than being incidental to lexical retrieval speed, brokering experience may therefore be a mechanism through which some heritage speakers accumulate the kind of effortful retrieval practice that Bjork's desirable difficulties framework associates with stronger, though not necessarily faster, long term language representations and processing.

4.2 Importance

Language brokering is a highly prevalent yet significantly under-researched phenomenon. One theory suggests that the lack of attention to language brokering stems from the marginalized status of children and immigrants in American society (Hall and Guéry, 2010). Despite their

critical roles in American society, their experiences have largely been overlooked in academia, perpetuating the marginalization of individuals with unique linguistic backgrounds. As heritage bilinguals, language brokers are often seen through a deficit lens, but this research joins efforts to establish models sensitive to the diverse experience of heritage bilinguals (Polinsky and Scontras, 2020). Elevating the experiences of language brokers in research has the potential to shed light on and integrate diverse forms of bilingualism into scholarly discourse. Critically, this research also serves to highlight the cognitive benefits of bilingual language experiences, combatting mythology about the potential detriments of bilingualism. Bilingualism itself has been stigmatized as deficient, however exploring diverse experiences, such as language brokering, holds the promise of revealing the cognitive benefits that may emerge from maintaining two or more languages in the brain.

Beyond its theoretical contributions, this dissertation has practical relevance for the communities where brokering is most common. Childhood brokering experience was linked to measurable differences in lexical-semantic processing, even though adulthood brokering was not. This tells us something important: early language brokering is not just a household responsibility with social and emotional consequences (Wong et al., 2017; Kim et al., 2020). It also leaves a distinct mark on how the brain processes language, one that current models of heritage bilingualism do not fully capture. The code-switching findings add to this picture. They show that everyday interactional habits, not just brokering itself, shape language processing in ways that are still often collapsed together in the literature. Together, these results suggest that heritage bilingual children who brokers are developing language skills through a distinct pathway.

This distinction matters for practice. Educators may be underestimating the linguistic sophistication that child brokers bring into the classroom, since brokering is often treated as a

source of stress rather than a form of skill-building. Clinicians assessing bilingual language ability may need to account for brokering history when interpreting processing differences, rather than treating all heritage bilinguals as a single comparison group. Policymakers designing support services for immigrant and refugee families should recognize that the children who broker are not just performing a task; they are undergoing an early and formative kind of language training with lasting cognitive effects. Taking childhood brokering seriously as a linguistic experience, and not only a social one, is a necessary step toward supporting these children well.

4.3 Limitations and Future Directions

Several limitations qualify the conclusions drawn here. Sample sizes in both studies, while consistent with prior work in this area (e.g., López & Vaid, 2018; Ferré et al., 2023), are modest relative to the number of fixed effects and interactions estimated. Effects of this kind, especially the small but consistent childhood-brokering effect, would benefit from replication in a larger sample capable of resolving these simple effects individually rather than only at the level of the overall interaction (Matuschek et al., 2017; Kumle et al., 2021).

A second limitation concerns the language brokering questionnaire itself. Because it was assembled specifically for this dissertation by combining and extending items from prior brokering measures (Kim et al., 2017; López, 2015), it has not yet undergone formal psychometric validation (underway in a forthcoming paper). While its component items are grounded in previously used measures, its expanded structure that capturing childhood and adulthood brokering separately along multiple dimensions would benefit from confirmatory factor analysis and reliability testing in a larger, independent sample before it can be treated as a fully validated instrument for future research on brokering.

Both studies are also cross-sectional, treating current brokering status and experience as static predictors of current performance, when brokering experience necessarily unfolds and changes over years. A longitudinal design following heritage bilinguals from the onset of brokering forward would allow stronger causal claims about whether childhood brokering shapes later language processing, rather than the current design's more limited ability to establish that the two co-occur. Related, Study 1's non-broker comparison group is drawn from a different country and testing site (Mexico) than the broker groups (Southern California), introducing potential confounds related to educational context, dialect, and general language-learning environment. Future work should attempt to address this more directly, for instance by recruiting heritage bilinguals from the same U.S. communities who have not served as brokers (but that we found difficult to find). A further open question for future work concerns why the Mandarin-English heritage bilinguals were faster than the other two groups on translation recognition. This pattern was not predicted in advance, and this dissertation does not attempt to explain it here, but it merits follow-up.

4.4 Conclusion

Language brokering is often treated, both in and outside of academia, as a single undifferentiated experience: bilingual children either serve as translators for their families or they do not. The two studies presented in this dissertation suggest that this categorical framing, while a reasonable starting point, obscures more than it reveals. What appears to matter is not brokering status alone but when brokering experience began, how it interacts with the typological relationship between a bilingual's two languages, and the broader interactional context in which each language is used day to day. Childhood brokering, specifically, showed a measurable association with semantic interference in translation recognition in Study 1, while

adulthood brokering did not; this is a dissociation broadly consistent with the idea that experiences occurring while the language system is still developing become embedded in its architecture in ways that later experiences do not. At the same time, the clearest group-level differences in Study 1 were better explained by the structural relationship between Spanish and English versus Mandarin and English than by brokering status itself, underscoring that any account of brokering's consequences must be considered jointly with the language pair in which brokering takes place. Study 2 extends this work using electrophysiological measures capable of detecting processing differences that reaction time alone may not reveal, and represents, to my knowledge, the first application of ERP methods to the study of language brokering. While it did not recover the childhood-specific semantic effect observed behaviorally in Study 1, it surfaced an unanticipated brokering-related effect on the topography of the response to form-related distractors, suggesting that brokering's neural signature, where it exists, may be organized differently than its behavioral signature, and pointing toward a more targeted, form-specific process for future work to pursue.

Together, this dissertation argues for a more differentiated understanding of language brokering, one that treats it not as a single switch that is either on or off, but as a graded and developmentally timed experience whose consequences for the bilingual language system are only beginning to be understood.

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APPENDIX A: Language Brokering Questionnaire

TRANSLATION EXPERIENCES

In this survey, you will be answering questions about your experience using both of your languages. It should take you approximately 15 minutes to complete.

I. Biographical Information

1. Are you an only child? ___ Yes ___ No
2. If you have siblings, how many do you have? (if only child, write 0) ____
3. If you have siblings, where do you place in your sibling order?

___ I am the oldest

___ I am one of the oldest

___ I am the middle sibling

___ I am one of the youngest

___ I am the youngest

___ Does not apply

II. Language Experience

1. In which language do you communicate best or feel more comfortable in each of the following environments?

1 - Only Spanish

2 - More Spanish than English

3 - Both equally

4 - More English than Spanish

5- Only English

a.	At home	1	2	3	4	5
b.	At school	1	2	3	4	5
c.	At work	1	2	3	4	5
d.	With friends	1	2	3	4	5

III. Translation Experience

A very common experience for people who know two or more languages is to translate for others. In the following section, we will ask questions regarding your experience translating for others.

Did you translate for others in childhood/adolescence? ___ Yes ___ No

In the past 6 months, have you translated for others? ___ Yes ___ No

Approximately at what age did you first translate for someone? (if you did not translate, write 0)

____ years old

Translation Experience – Childhood (Yes)

Next we will ask you questions about your experience translating as a child and/or adolescent.

1. When you were a child and/or adolescent, how often did you translate for the following people in your life?

0 - Does not apply

1 - Never

2 - Rarely

3 - Sometimes

4 - Often

5 - Always

a.	Parent(s) / Legal Guardian(s) / Caretaker(s)	0 1 2 3 4 5
b.	Grandparent(s)	0 1 2 3 4 5
c.	Younger sibling(s)	0 1 2 3 4 5
d.	Older sibling(s)	0 1 2 3 4 5
e.	Other family members	0 1 2 3 4 5
f.	Friends	0 1 2 3 4 5
g.	Strangers	0 1 2 3 4 5

2. When you were a child and/or adolescent, how often did you translate speech in the following settings?

0 - Does not apply

1 - Never

2 - Rarely

3 - Sometimes

4 - Often

5 - Always

a.	Home (e.g., phone calls)	0	1	2	3	4	5
b.	School (e.g., parent-teacher conference)	0	1	2	3	4	5
c.	Stores (e.g., grocery stores, retail stores)	0	1	2	3	4	5
d.	Church (e.g., sermon, conversations)	0	1	2	3	4	5
e.	Medical settings (e.g., doctor's appointments)	0	1	2	3	4	5
f.	Restaurants (e.g., ordering food)	0	1	2	3	4	5
g.	Finance (e.g., banks)	0	1	2	3	4	5
h.	Government offices	0	1	2	3	4	5
i.	Legal matters (e.g., lawyers)	0	1	2	3	4	5
j.	On the street	0	1	2	3	4	5

3. When you were a child and/or adolescent, how often did you translate text in the following settings?

0 - Does not apply

1 - Never

2 - Rarely

3 - Sometimes

4 - Often

5 - Always

k.	Home	0	1	2	3	4	5
l.	School (report cards, permission slips, homework)	0	1	2	3	4	5

m.	Stores	0	1	2	3	4	5
n.	Church (e.g., church pamphlets)	0	1	2	3	4	5
o.	Medical settings (e.g., medical forms)	0	1	2	3	4	5
p.	Restaurants (e.g., menus)	0	1	2	3	4	5
q.	Finance (e.g., bank statements, bills)	0	1	2	3	4	5
r.	Government office	0	1	2	3	4	5
s.	Legal matters	0	1	2	3	4	5
t.	On the street	0	1	2	3	4	5

4. Please indicate how strongly you agree/disagree with the following statements regarding your experience translating as a child and/or adolescent.

1 - Strongly disagree

2 - Disagree

3 - Neutral

4 - Agree

5 - Strongly agree

Translating helped me learn English.

1 2 3 4 5

Translating helped me learn Spanish.

1 2 3 4 5

Translating made me feel insecure about my English.

1 2 3 4 5

Translating made me feel insecure about my Spanish.

1 2 3 4 5

I was good at translating for others.

1 2 3 4 5

Translating for others made me feel more mature and independent.

1 2 3 4 5

Translating gave me a greater self-esteem.

1 2 3 4 5

Translating gave me a lower self-esteem.

1 2 3 4 5

Translating made me feel confident about my social and communication skills.

1 2 3 4 5

Translating for others was a burden.

1 2 3 4 5

Translating for others was stressful.

1 2 3 4 5

Translating helped me understand my family better.

1 2 3 4 5

Translating helped me bond with my family.

1 2 3 4 5

Translating worsened my relationship with my family.

1 2 3 4 5

Translating made my parents learn English faster.

1 2 3 4 5

Translating made my parents learn English slower.

1 2 3 4 5

Translating made me feel like my family's protector.

1 2 3 4 5

Translating was a source of pride for me.

1 2 3 4 5

Translating was important to my identity.

1 2 3 4 5

Translating helped me better understand people from other cultures.

1 2 3 4 5

Translating made me feel a stronger sense of responsibility for my community.

1 2 3 4 5

Translating was a source of shame for me.

1 2 3 4 5

Translating was not important to my identity.

1 2 3 4 5

Translation Experience – Childhood (No)

Next we will ask you to imagine your experience if you would have translated as a child and/or adolescent.

1. Please indicate to the best of your ability how strongly you would have agreed/disagreed with the following statements if you would have translated as a child and/or adolescent.

1 - Strongly disagree

2 - Disagree

3 - Neutral

4 - Agree

5 - Strongly agree

Translating would have helped me learn English.

1 2 3 4 5

Translating would have helped me learn Spanish.

1 2 3 4 5

Translating would have made me feel insecure about my English.

1 2 3 4 5

Translating would have made me feel insecure about my Spanish.

1 2 3 4 5

I would have been good at translating for others.

1 2 3 4 5

Translating for others would have made me feel more mature and independent.

1 2 3 4 5

Translating would have given me a greater self-esteem.

1 2 3 4 5

Translating would have given me a lower self-esteem.

1 2 3 4 5

Translating would have made me feel confident about my social and communication skills.

1 2 3 4 5

Translating for others would have been a burden.

1 2 3 4 5

Translating for others would have been stressful.

1 2 3 4 5

Translating would have helped me understand my family better.

1 2 3 4 5

Translating would have helped me bond with my family.

1 2 3 4 5

Translating would have worsened my relationship with my family.

1 2 3 4 5

Translating would have made my parents learn English faster.

1 2 3 4 5

Translating would have made my parents learn English slower.

1 2 3 4 5

Translating would have made me feel like my family's protector.

1 2 3 4 5

Translating would have been a source of pride for me.

1 2 3 4 5

Translating would have been important to my identity.

1 2 3 4 5

Translating would have helped me better understand people from other cultures.

1 2 3 4 5

Translating would have made me feel a stronger sense of responsibility for my community.

1 2 3 4 5

Translating would have been a source of shame for me.

1 2 3 4 5

Translating would have been not important to my identity.

1 2 3 4 5

Translation Experience – Adulthood (Yes)

Next we will ask you questions about your current experience translating.

1. Currently, how often do you translate for the following people in your life?

0 - Does not apply

1 - Never

2 - Rarely

3 - Sometimes

4 - Often

5 - Always

a.	Parent(s) / Legal Guardian(s) / Caretaker(s)	0 1 2 3 4 5
b.	Grandparent(s)	0 1 2 3 4 5
c.	Younger sibling(s)	0 1 2 3 4 5
d.	Older sibling(s)	0 1 2 3 4 5
e.	Other family members	0 1 2 3 4 5
f.	Friends	0 1 2 3 4 5
g.	Strangers	0 1 2 3 4 5

2. Currently, how often do you translate speech in the following settings?

0 - Does not apply

1 - Never

2 - Rarely

3 - Sometimes

4 - Often

5 - Always

a.	Home (e.g., phone calls)	0	1	2	3	4	5
b.	School (e.g., parent-teacher conference)	0	1	2	3	4	5
c.	Stores (e.g., grocery stores, retail stores)	0	1	2	3	4	5
d.	Church (e.g., sermon, conversations)	0	1	2	3	4	5
e.	Medical settings (e.g., doctor's appointments)	0	1	2	3	4	5
f.	Restaurants (e.g., ordering food)	0	1	2	3	4	5
g.	Finance (e.g., banks)	0	1	2	3	4	5
h.	Government offices	0	1	2	3	4	5
i.	Legal matters (e.g., lawyers)	0	1	2	3	4	5
j.	On the street	0	1	2	3	4	5

3. Currently, how often do you translate text in the following settings?

0 - Does not apply

1 - Never

2 - Rarely

3 - Sometimes

4 - Often

5 - Always

k.	Home	0	1	2	3	4	5
l.	School (report cards, permission slips, homework)	0	1	2	3	4	5
m.	Stores	0	1	2	3	4	5
n.	Church (e.g., church pamphlets)	0	1	2	3	4	5
o.	Medical settings (e.g., medical forms)	0	1	2	3	4	5
p.	Restaurants (e.g., menus)	0	1	2	3	4	5
q.	Finance (e.g., bank statements, bills)	0	1	2	3	4	5
r.	Government office	0	1	2	3	4	5
s.	Legal matters	0	1	2	3	4	5
t.	On the street	0	1	2	3	4	5

4. Please indicate how strongly you agree/disagree with the following statements regarding your current experience translating.

1 - Strongly disagree

2 - Disagree

3 - Neutral

4 - Agree

5 - Strongly agree

Translating helps me learn English.

1 2 3 4 5

Translating helps me learn Spanish.

1 2 3 4 5

Translating makes me feel insecure about my English.

1 2 3 4 5

Translating makes me feel insecure about my Spanish.

1 2 3 4 5

I am good at translating for others.

1 2 3 4 5

Translating for others makes me feel more mature and independent.

1 2 3 4 5

Translating gives me a greater self-esteem.

1 2 3 4 5

Translating gives me a lower self-esteem.

1 2 3 4 5

Translating makes me feel confident about my social and communication skills.

1 2 3 4 5

Translating for others is a burden.

1 2 3 4 5

Translating for others is stressful.

1 2 3 4 5

Translating helps me understand my family better.

1 2 3 4 5

Translating helps me bond with my family.

1 2 3 4 5

Translating worsens my relationship with my family.

1 2 3 4 5

Translating makes my parents learn English faster.

1 2 3 4 5

Translating makes my parents learn English slower.

1 2 3 4 5

Translating makes me feel like my family's protector.

1 2 3 4 5

Translating is a source of pride for me.

1 2 3 4 5

Translating is important to my identity.

1 2 3 4 5

Translating helps me better understand people from other cultures.

1 2 3 4 5

Translating makes me feel a stronger sense of responsibility for my community.

1 2 3 4 5

Translating is a source of shame for me.

1 2 3 4 5

Translating is not important to my identity.

1 2 3 4 5

Translation Experience – Adulthood (No)

Next we will ask you to imagine your experience if you were to translate now.

Please indicate to the best of your ability how strongly you would have agreed/disagreed with the following statements if you were to translate now.

1 - Strongly disagree

2 - Disagree

3 - Neutral

4 - Agree

5 - Strongly agree

Translating would help me learn English.

1 2 3 4 5

Translating would help me learn Spanish.

1 2 3 4 5

Translating would make me feel insecure about my English.

1 2 3 4 5

Translating would make me feel insecure about my Spanish.

1 2 3 4 5

I would be good at translating for others.

1 2 3 4 5

Translating for others would make me feel more mature and independent.

1 2 3 4 5

Translating would give me a greater self-esteem.

1 2 3 4 5

Translating would give me a lower self-esteem.

1 2 3 4 5

Translating would make me feel confident about my social and communication skills.

1 2 3 4 5

Translating for others would be a burden.

1 2 3 4 5

Translating for others would be stressful.

1 2 3 4 5

Translating would help me understand my family better.

1 2 3 4 5

Translating would help me bond with my family.

1 2 3 4 5

Translating would worsen my relationship with my family.

1 2 3 4 5

Translating would make my parents learn English faster.

1 2 3 4 5

Translating would make my parents learn English slower.

1 2 3 4 5

Translating would make me feel like my family's protector.

1 2 3 4 5

Translating would be a source of pride for me.

1 2 3 4 5

Translating would be important to my identity.

1 2 3 4 5

Translating would help me better understand people from other cultures.

1 2 3 4 5

Translating would make me feel a stronger sense of responsibility for my community.

1 2 3 4 5

Translating would be a source of shame for me.

1 2 3 4 5

Translating would not be important to my identity.

1 2 3 4 5