ABSTRACT

Title of Dissertation: THE ROLE OF TASK DEMANDS, PROFICIENCY, AND ORTHOGRAPHY IN BILINGUAL LANGUAGE SWITCHING

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The current study explores language switching in bilinguals and investigates how task demands, proficiency, and orthography contribute to switching costs and patterns between languages. Korean-English bilinguals participated in this study and completed a bilingual naming task in either *Hangeul*/English or Korean romanization/English, a language-inclusive lexical decision task (also in *Hangeul*/English or Korean romanization/English), a language background questionnaire, and two proficiency measures: an English cloze test and the English Elicited Imitation Test (EIT).

The bilingual naming task was designed to measure language switching in production, while the lexical decision task assessed switching in comprehension. The task was visually the same, however, participants were asked to name words in one task and recognize words in the other. Participants were assigned to either the *Hangeul*/English or the Korean romanization/English condition and completed both

tasks within their assigned condition. All seventy-five participants included in this study achieved at least 70% accuracy on both tasks. At the time of the study, all were living in an English-speaking country, with Korean as their first language (L1) and English as their second language (L2).

In the naming task under the *Hangeul*/English condition, switching costs were greater when switching from L2 English to L1 Korean than in the reverse direction. However, in the version of the task with Korean romanization (instead of *Hangeul*), the pattern was reversed: switching from L1 Korean to L2 English incurred greater costs. In the lexical decision task, switching costs were symmetrical for the *Hangeul* group but asymmetrical for the romanization group, with greater costs observed when switching from L1 Korean to L2 English. Proficiency, as measured by the EIT, played a significant role in reaction times across most tasks.

These findings are discussed in relation to theoretical models of bilingual language control, with particular attention to how different task demands, orthographic representations, and L2 proficiency modulate switching costs.

THE ROLE OF TASK DEMANDS, PROFICIENCY, AND ORTHOGRAPHY IN BILINGUAL LANGUAGE SWITCHING

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Dedication

To my grandmother, who immigrated from South Korea to the United States in pursuit of greater opportunities for her family.

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Chapter 1: Introduction

Bilinguals often switch from one language to another in production and comprehension. For example, a Korean-English bilingual may decide to systematically switch from Korean to English entirely depending on their audience, or use English words throughout their Korean conversation with other Korean-English bilinguals. Or, the same Korean-English bilingual will activate Korean words as they are reading English text or access both languages during word retrieval. Switching between languages has been widely investigated in a number of ways to better understand how language and cognition works in bilinguals (see Declerck & Phillipp, 2015 for a review) beginning as early as the 1960’s with the first language switching in comprehension study by Kolers (1966) and the first language switching in production study by Macnamara, Krauthammer, and Bolgar (1968). However, language switching studies in production are very different from those on comprehension in regards to the different processes involved, the methods used, and the results obtained. Also, the field has grown since these early studies to include a variety of tasks, bilinguals, and languages.

For language switching in production, most recent studies involve the presentation of bivalent stimuli such as pictures or digits that can be named in either language. Cues such as background colors, shapes, or country flags are used to indicate which language should be used by the participants. In such cases, participants must integrate different sources of visual information (picture/digit and cue) before producing a word, which can lead to mental load challenges, since the picture/digit and cue are changing on a trial to trial basis. Participants must also keep track of which cue represents which language. Since switching between languages is frequent and random during these tasks, the inhibition of the irrelevant language may also become necessary for participants to complete the task efficiently.

On the other hand, in a switching study where a comprehension task is adopted, participants are usually asked to decide whether a word on a screen exists in one or both languages, if the word presented is animate, or belongs to a certain category (e.g., animals). Similar to a language switching production task, a comprehension task necessitates the activation of both languages, and the switching of languages in comprehension can also be frequent and unpredictable. However, a comprehension task is different from a production task in that the active selection of a language is not required on the part of the participant. In addition, comprehension tasks often involve univalent stimuli that can only be processed in one language (e.g., words). Meanwhile, production tasks involve bivalent stimuli (e.g., pictures and digits) that can activate both languages simultaneously. This project considers whether these task differences between production and comprehension may affect bilingual speakers' language switching patterns and how their switching patterns are affected by additional factors such as participant proficiency and valency of experimental stimuli.

To measure language switching costs in production and comprehension, bilingual participants are presented stimuli (e.g., pictures, digits, or words) and asked to name or respond to stimuli one by one. Bilinguals tend to be more accurate and faster when naming or responding to a stimulus that is the same language as the preceding trial (i.e., nonswitch trial) compared to when a different language is used (i.e., switch trial). To investigate the L1 switching cost (i.e., the cost of switching into the L1), participants' reaction times (RTs) on the L1-L1 and L2-L1 trials can be subtracted. Likewise, to investigate the L2 switching costs (i.e., the cost of switching into the L2), participants' RT on the L2-L2 and L1-L2 conditions can be subtracted.

With regard to these L1 and L2 switching costs, bilinguals appear to face more difficulties switching from their second language (L2) to their first language (L1) than the other way around in production (Jackson, Swainson, Cunnington, & Jackson, 2001; Macizo, Bajo, & Paolieri, 2012; Meuter & Allport, 1999; Philipp, Gade, & Koch, 2007). In other words, the cost of switching from the L2 to L1 (i.e., L1 switching cost) is greater than switching from L1 to L2 (i.e., L2 switching cost) in production tasks. The greater cost associated with switching from one's L2 to L1 is somewhat counterintuitive, since bilinguals are more proficient and fluent in their native L1 and should be able to switch back to their L1 efficiently. The difference in switching costs in the L1 to L2 direction compared to the L2 to L1 direction is often referred to as the asymmetrical language switching cost.

Another unexpected finding can be observed in language switching studies where researchers compare participant performance on a single language versus a mixed language task block. Many studies have shown slower performance on nonswitch trials (e.g., L1-L1 and L2-L2) in mixed language blocks compared to pure, single language blocks (Christoffels, Firk, & Schiller, 2007; Prior & Gollan, 2013; Gollan & Ferreira, 2009), which is understandable due to the extra processing required to complete a mixed language task compared to a single language task. Rather surprisingly, there also appears to be an L2 advantage in the mixed language task (or, a reversed language dominance effect) where RTs to L2 stimuli are faster than L1 stimuli regardless of the preceding trial.

While these switching and mixing costs are measured systematically across studies, there is quite a bit of variation in language switching experimental designs. For example, researchers may use pictures, numbers, colors, words, or any combination of those as experimental stimuli. Certain studies may ask participants to respond using a specific language utilizing cues, by blocks, or using set language sequences, and the ratio of nonswitch and switch conditions in an experiment can vary across studies. Furthermore, some studies use repeated stimuli throughout their study (e.g., digits 1-9) and to varying degrees, or delay the presentation of a language cue (Philipp et al., 2007; Verhoef, Roelofs, & Chwilla, 2009, to name a couple). Due to this variation among language switching studies, comparing studies directly is often challenging.

Also, there are still lingering questions on how language control operates in bilinguals and if there are other mechanisms that allow bilinguals to switch between their languages. For example, in addition to the language control mechanism, researchers hypothesize that language switching ability may be linked to cognitive control and other domain-general abilities, such as executive functioning (de Bruin, Roelofs, Dijkstra, & FitzPatrick, 2014; Linck, Schwieter, & Sunderman, 2020). Furthermore, in comprehension, the pattern is less clear where language switching costs can be symmetrical (especially in semantic categorization tasks) or asymmetrical in the opposite L1-L2 direction. Understanding asymmetrical switching costs in production and comprehension has been a major research question in this field and will be the focus for this dissertation.

The following literature review will cover some of the main research questions and current findings in the field as well as the different types of theories and tasks that are used in language switching research as well as the motivation for the present study. While the range of language switching studies is rather broad and includes electrophysiological studies (Christoffels et al., 2007; Jackson et al., 2001; Verhoef et al., 2009) to those looking at executive control and functioning (Calabria, Hernández, Branzi, & Costa, 2012; Linck et al., 2020; Prior & Gollan, 2013; Struck & Jiang, 2022; Struys, Woumans, Nour, Kepinska, & van den Noort, 2019 to name a few) and even studies on children (Jia, Kohnert, Collado, & Aquino-Garci, 2006; Kohnert, 2002), the focus in this dissertation will be on behavioral studies in bilingual adults and the switching costs observed in language switching in production and comprehension at the word level. Some of the gaps in the literature will be addressed, and a study aiming to fill those gaps will be described.

Chapter 2: Background and Literature Review

2.1 Language switching in production

In bilingual language processing, bilinguals coactivate both languages automatically. However, the ability to limit processing to the relevant language and switch between languages is referred to as language control. In spoken word production, language control refers to the capability of bilinguals to speak in the relevant and intended language while avoiding interference from the irrelevant and unintended language. Bilinguals who switch to their L1 in production often face a larger processing cost than switching to their L2. This finding has been observed since the landmark study on language switching in production by Meuter and Allport (1999) where they used a digit naming paradigm to measure language switching performance in a heterogenous group of bilinguals. Meuter and Allport's (1999) design and utilization of numbers 1-9 and colors for language cues in their naming task would soon become the most prevalent way for testing language switching in production. Their support of Green's (1998) Inhibitory Control Model (ICM) as an explanation for language switching continues on to the present day.

Green's (1998) ICM model theorized that bilinguals speaking in one language are actively inhibiting their other, irrelevant language. More inhibition is needed to suppress the L1 when it is irrelevant, and the reactivation of the L1 becomes more difficult in a switch trial where it suddenly becomes relevant. The ICM is frequently used to explain the production studies where there is a greater L1 than L2 switching cost (Jackson et al., 2001; Macizo et al., 2012; Meuter & Allport, 2000; Philipp et al., 2007). To describe the ICM in detail, the model assumes that there is competition from task schemas. For example, individuals who are asked to name the color of a word (task schema #1: naming colors) may face interference from reading the word (task schema #2: reading words), especially if the word does not match the color as seen in incongruent trials of Stroop tasks (Stroop, 1935). The tasks of word naming and color naming are competing against each other not unlike what we see in bilingual language switching studies where bilinguals are asked to name words or pictures based on a cue, or determine whether words displayed are animate or fit within a given semantic category.

In addition to competition between task schemas, Green's ICM (1998) also states that all lemmas[1] have language tags, and each lemma has an L1 or L2 tag. For example, a Korean-English bilingual whose first language is Korean has a L1 tag for the word *chaek* and an L2 tag for the translated word "book." Language-specific lemmas can be activated or suppressed according to the ICM via external sources (such as hearing words or reading them) or from the conceptual system (e.g., a bilingual's mental lexicon). The ICM supposes that the L1 lemma must be inhibited for the L2 lemma to remain active and that "it takes time for the effects of prior inhibition to be overcome." (p.72).

The ICM also references the Kroll and Stewart's (1994) revised hierarchical model (RHM), which is still referenced as an explanation of bilingual word production (Kroll, van Hell, Tokowicz, & Green, 2010). The RHM hypothesizes that there is a direct link between words and concepts in the L1, but for L2 words, the L1 is needed to link L2 words and concepts to each other until bilinguals can reach a certain level of proficiency and access meaning directly from L2 words to concepts. However, these models do not provide an explanation on the asymmetry observed in production studies where bilinguals incur an L1 switching cost or describe in depth how some bilinguals are able to switch effortlessly between their L1 and L2 as seen in studies

[1] According to Jiang (2000), a lemma contains semantic and syntactic information about a word, such as word meaning and part of speech (e.g., noun, verb, adjective, etc.).

where highly proficient, balanced bilinguals are involved (Costa & Santesteban, 2004; Costa, Santesteban, & Ivanova, 2006; Schwieter & Sunderman, 2008)

According to Green (1998), language switching takes time because there is a change in language for a given task and “any change in language involves overcoming the inhibition of previous language tags” (p. 73). However, the challenge of language switching does not appear to be universal. In fact, there is evidence that language switching can be effortless and L1 and L2 switching costs are similar/symmetrical in certain bilinguals (Costa & Santesteban, 2004; Costa et al. 2006; Schwieter & Sunderman, 2008). Meuter and Allport (1999) shared specific predictions for bilinguals switching from their L2 to L1. The authors believed that the degree of asymmetry in language switching cost depends on the relative strength of the bilinguals’ two languages. They specifically predicted that the more equal in strength the two languages, the smaller the expected asymmetry in switching cost. More on the role of proficiency will be discussed in section 2.4.

In direct opposition to the ICM is the response selection hypothesis by Finkbeiner, Almedia, Janssen, and Caramezza (2006). According to Finkbeiner et al. 2006, there are two main issues that may create the impression of language suppression. One issue is the incorporation of two tasks that differ in difficulty, since a greater switch cost is usually found for the easier task as in Allport, Styles, and Hsieh (1994) where participants switched between the more challenging task of naming the color of words and the easier task of naming the words only. Participants in the aforementioned study took longer to switch to the easier word naming task than the more challenging color naming task analogous to what we see in production tasks where participants take longer to switch to their native L1. The second issue is the use of bivalent stimuli in language switching experiments (e.g., pictures and digits), which are presented to participants with an L1 or L2 cue and can activate and elicit both L1 and L2 responses.

Finkbeiner et al. (2006) suggested that switching costs are solely obtained with bivalent stimuli (which can be named differently in two languages), but not with univalent stimuli (which must be named in a single language) and tested this in their three experiments where they found no switching costs from a L2 bivalent digit naming task to 1) a L1 univalent picture naming task (Experiment 1) and 2) a L1 univalent dot naming task (Experiment 2). Participants named pictures and dots in their L1 equally fast regardless of the language used for digit naming in the previous trial. Meanwhile, in these two experiments, Finkbeiner et al. (2006) found the usual, asymmetrical switching cost for the digit naming when participants named digits from their L2 to L1. A follow-up study by Peeters, Runnqvist, Bertrand, and Grainger (2014) challenged Finkbeiner et al. (2006) response selection hypothesis by replicating their study with some modifications (namely, univalent pictures and bivalent words) and found robust asymmetrical switching costs when switching into the dominant, L1 language. In regards to univalent and bivalent stimuli, however, digits, dots, and pictures are naturally all bivalent in that they can be named in either language by bilinguals. In these studies, researchers are artificially instructing participants to name certain stimuli in their L1 without considering how inherently univalent and bivalent certain stimuli are. More discussion on the question of valency in language switching will be presented in section 2.5.

An additional challenge to the ICM is the idea of reactive activation (Philipp et al., 2007) where the authors suggest that the weaker language is persistently activated. These authors are among the first to include three languages in their study (for majority of participants: L1 German, L2 English, and L3 French) and different cue-stimulus intervals (i.e., interval between cue and stimulus). In their Experiment 1 looking at trilinguals' two languages at a time, Philipp et al. 2007 observed asymmetrical switching costs in participants' L1/L2, L1/L3, and L2/L3 blocks with larger switching costs in the dominant language regardless of cue-stimulus interval length (100 ms. or 1000 ms.). The authors sought to test their hypothesis that the weaker language is persistently activated by comparing performance between n-2 repetition trials (e.g., L1-L2-L1) with n-2 switch trials (e.g., L3-L2-L1) in their Experiment 2. The results indicated that n-2 repetition costs (i.e., the difference between n-2 repetition trials and n-2 switch trials) differed for the L1 compared to the L2 and L3, suggesting different levels of inhibition by language. Unexpectedly, there was a larger n-2 repetition cost for the L3 (60 ms.) than the L2 (22 ms.) with a 100 ms. cue-stimulus interval, which may challenge the assumptions of the dominance-related inhibition account by Green (1998). However, n-2 repetition costs require three languages to be measured in a single task, and the majority of studies in this field focus on bilinguals and their two languages.

Challenging all previous accounts, Verhoef et al. (2009) believed that there is a L1 repeat benefit such that L1 nonswitch, repeat trials are speeded due to an absence of L2 language competition. The authors decided to introduce short or long periods of time (in other words, cue-stimulus intervals) to help participants prepare for the response language in advance to boost picture naming performance in the other conditions (L2 repeat/nonswitch, L1 switch, and L2 switch). The authors found symmetrical switch costs on long cue-stimulus intervals (1250 ms.) and asymmetrical switch costs on short cue-stimulus intervals (500 ms.) due to faster RTs on the other three conditions in the long cue-stimulus interval condition. Also, the authors confirmed that the only condition that did not show a benefit of preparation was the L1 nonswitch, repeat condition. However, bringing up the previous study by Philipp et al. (2007), asymmetrical switch costs were observed regardless of the cue-stimulus interval (100 ms. or 1000 ms.) Also, Mosca and Clahsen (2016) found symmetrical switching costs in their no-preparation trials and an absence of language switching costs in their with-preparation trials. Thus, Verhoef et al.'s 2009 L1 repeat benefit hypothesis does not seem universal (see also Fink & Goldrick 2015's replication of Verhoef et al. 2009).

Bobb and Wodniecka's (2013)'s review article also seems to question the relationship between switch costs and the inhibition explanation by citing the alternative explanations, highlighting the great variety in task differences among studies, and proposing a proficiency explanation, which will be discussed further in the proficiency section in 2.4. One of the issues with a proficiency explanation is that proficiency measures and questionnaires vary greatly across language switching studies. Thus, while the inhibition account is the most cited explanation for asymmetrical language switching, there may be other possible reasons for the asymmetry observed in language switching studies in production.

2.2. Language switching in comprehension

In terms of quantity, there are substantially fewer comprehension-based studies on language switching. Among the comprehension-based studies, the most frequently cited is Grainger and Beauvillain's (1987) study using a language inclusive lexical decision task. However, their interest was not specifically on language switching, but on bilingual lexical access and whether lexical access for bilinguals is a purely bottom-up procedure or regulated by the language that the bilingual is currently using (i.e., their language mode).

Grainger and Beauvillain's (1987) language inclusive lexical decision task (Experiment 1) allowed participants to respond yes if the word displayed was French or English. The authors reported that the French-English bilinguals took longer to respond to L2 English words when displayed right before L1 French words compared to the other way around in their first experiment using target words that were all orthographically legal in both languages. Note that this result is not in line with previous production-based studies where there tends to be an asymmetric, larger L1 switching cost (from L2 to L1) compared to the L2 switching cost (from L1 to L2). In Grainger and Beauvillain's (1987) first experiment, we see some evidence of a possible L2 switching cost. The mean RT for L2 to L1 switch trials was 637 ms. and the mean RT for L1 to L2 switch trials was 674 ms. Their follow-up experiment (Experiment 2) explored this further using language-specific orthographic information. Looking at their Experiment 2 results, we see a slightly clearer L2 switching cost where it takes longer for the French-English bilinguals to respond to L2 English words after L1 French words. The L2 switching cost was greater with words that were language-specific (clearly French or English) than non-specific (could be read or pronounced in either French or English) suggesting that orthography may play a role in language switching in comprehension.

As a follow up to the Grainger and Beauvillain (1987) study, Thomas and Allport (2000) did a replication study using a language inclusive lexical decision task with nonwords that were and were not specific to French and English (Exp. 1). One of the issues Thomas and Allport (2000) emphasized in their study was that Grainger and Beauvillian (1987) used the same nonwords across their two experiments and that these language-specific nonwords could have created an orthography-based strategy among participants. Although Thomas and Allport (2000) reported switching costs, it is unclear whether the authors delineated L1 and L2 switching costs. Their research interest was mainly focused on comparing the differences between RTs in the non-specific (words can be read/pronounced in either French and English) and language-specific (French or English) conditions. In Experiment 1, the authors reported switch costs of 52 ms. for words with non-specific orthography and switch costs of 69 ms. for words with language-specific orthography, but do not report these switch costs by language. The switch costs by language are not provided in their two follow-up experiments using a language-exclusive lexical decision task.

Von Studnitz and Green (1997) is another early comprehension study, but unlike Thomas and Allport (2000), they reported the descriptive data by language and utilized a homogeneous group of German-English bilinguals whose native language was German. Their first experiment was a cued lexical decision task where backgrounds were color-coded to indicate relevant language, and their second experiment was a language inclusive lexical decision task where participants could respond “yes” or “no” to words that were in German and English. In the von Studnitz and Green’s (1997) study, we see a pattern of larger L2 switching costs in their first and second experiments, with a significant interaction between trial type (switch/non-switch) and language (German/English) in the second experiment. This L2 switching cost was also observed in Aparicio and Lavaur (2014) in their Experiment 1 with bilinguals. The authors in that study used the same stimuli as Grainger and Beauvillain (1987) and found a similar L2 switching cost with their group of French-English bilinguals, where target words were processed more slowly in the L1 to L2 (45 ms.) direction compared to the L2 to L1 (30 ms.) direction. Greater L2 switch costs were also observed in Koeth (2012) where the L1 to L2 switching cost was 33.7 ms. (*SD* = 51.1 ms.) and L2 to L1 switching cost was 18.6 ms. (*SD* = 40.8 ms.) and in Struck and Jiang (2022) where the L1 to L2 switching cost was 54 ms. and the L2 to L1 switching cost was 14 ms.

However, not all comprehension studies show this pattern of a larger L2 switching cost. There are a few comprehension studies that show symmetrical switching costs or an L1 switching cost similar to those seen in production studies. For example, Mosca and de Bot

(2017) found an L1 switching cost of 35 ms. and a substantially smaller L2 switching cost of -2 ms. in their language inclusive LDT. In Ong, McKague, Weekes, and Sewell (2019)'s study, interactions between switch trial status and language in their models did not significantly improve model fit suggesting symmetric switching costs in their lexical decision tasks.[2] Also, a replication study of Struck and Jiang (2022) by Mahraj (2023) showed a L1 switching cost not seen in the original study.

In addition, while most comprehension-based studies utilized the lexical decision task, there are those that used semantic categorization tasks (e.g., Declerck, Koch, Duñabeitia, Grainger, & Stephan, 2019 Experiment 7; Koeth, 2012 Experiment 3; Macizo et al., 2012; Struys et al., 2019) which involves bilingual participants reading words on a screen and deciding which category (animacy, for example) the words belong to. In the Macizo et al. 2010 study, the authors split the groups based on self-reported ratings of L2 speech fluency, speech comprehension, writing proficiency, and reading proficiency. With highly proficient Spanish-English bilinguals, Macizo et al. 2012 found no asymmetrical language switching, since L1-L2 switches (120 ms.) and L2-L1 (139 ms.) switches produced a similar cost. The authors also found no asymmetrical switching costs with Spanish-English bilinguals with low L2 proficiency. The magnitude of the switching cost for these low proficient bilinguals for L2-L1 was 11 ms., and it was 28 ms. for the L2-L1 direction. For Koeth (2012), a similar pattern arose where Korean-English bilinguals showed symmetrical switching costs in the semantic categorization task (18.2 ms. for L2 switching cost and 20.1 ms. for L1 switching cost). Also, symmetrical switching costs were seen in Struys et. al (2019) with their semantic categorization task (23.79 ms. for L2-L1 and 4.13 ms. for L1-L2). It's clear that the magnitude of switching costs are

[2] Note that the interaction for the lexical decision task that had Spanish and English words/nonwords in randomized order (Exp. 1) was marginally significant (p = .073).

variable across studies, but as a whole, the semantic categorization tasks seem to produce a symmetric switching cost where the interaction between language and trial type is not significant.

Additional comprehension tasks include magnitude and parity tasks (as seen in Declerck et al. 2019) where participants are asked to indicate whether a number was larger or smaller than a certain number or whether a number was odd or even, respectively. Declerck et al. 2019 found symmetrical switching costs for both the magnitude and parity tasks in Experiment 1. In Experiment 2 where participants were cued trial-by-trial on whether to complete a magnitude or parity task, no language switch costs were observed, but task-switch costs were. Experiment 3 split the French and English words into audio or visual presentation keeping all other experimental design components intact, and no language switch costs were observed (only modality switch costs).

In terms of comprehension, the Bilingual Interactive Activation Model+ (Dijkstra & van Heuven, 1998) and its updated Multilink model (Dijkstra, Wahl, Buytenhuijs, van Halem, Al-Jibouri, de Korte, & Rekké, 2019) may provide some predictions on how bilinguals process words in both their languages, especially with regard to comprehension and recognition. Aspects of Green's 1998 Inhibitory Control model were applied to the BIA+, such as the separation of the task system and word identification system. The BIA+ model works solely from the bottom-up from the activation of orthographic words and its candidates (within and between languages) to their phonology and semantics. This model assumes that if two languages differ in terms of orthography (e.g., diacritical markers, language specific consonant clusters, or script), the initial set of lexical candidates may be limited to that language. The BIA+ model seems to suggest that L2 phonological and semantic levels face delays in activation compared to the L1, which may explain the greater L2 switching cost observed in these comprehension studies. In the revised Multilink, the authors propose that activation from a written word activates the orthographic layer, language membership, semantics, and phonology all in bidirectional ways and make no predictions about activation delays in L1 versus the L2.

The delay for L2 versus L1 written input described by the BIA+ model could be a possible explanation for the L2 switching cost that is observed in comprehension more often than production. However, conclusions regarding language switching in comprehension are tentative at best, and it's not clear why there are differences among comprehension-based language switching studies (e.g., LDT vs. semantic categorization/parity) and between comprehension and production studies.

2.3. Importance of comparing switch costs in production and comprehension

Language switching involves different demands and processes for production versus comprehension in bilinguals. For production tasks, bilinguals must actively select a language based on cues/instructions to complete the task. Language control becomes an important aspect of language switching in production especially with bivalent stimuli (e.g., pictures/digits) and cues, since a bilingual can name bivalent stimuli in both languages and may need to inhibit the irrelevant language on every trial. However, for comprehension, participants are processing words (in most cases) and only required to assess whether those words are legal (or in some cases, animate or part of a larger category) in one or both languages. In comprehension, participants select language based on the input provided (e.g., orthography) and with this input, they may be better able to inhibit the irrelevant language due to less competition. Language control may therefore be differentially involved in comprehension versus production due to these different processing stages. The idea that there are different stages involved in language switching in production and comprehension is discussed in Jiang (2023).

Phonological encoding and articulation, in an example, are necessary steps in production tasks that are not needed in comprehension (Declerck, Koch, & Philipp, 2013). Declerck et al. (2013) seems to suggest smaller switch costs for comprehension, since phonological encoding and articulation are not necessarily involved for comprehension tasks. A recent publication by Li, Midgley, Ferreira, Holcomb, and Gollan (2024) emphasizes that, for production, language control mechanisms are triggered by endogenous, internal factors such as intending to speak in a certain language, but by exogenous, external factors for comprehension such as seeing a word written in a language.

In terms of production and comprehension, only a few researchers have attempted to look at both in a single study (Jylkkä, Lehtonen, Lindholm, Kuusakoski, & Laine, 2018a; Jylkkä et al., 2018b; Li et al. 2024; Macizo et al., 2012; Mosca & de Bot, 2017). One of such studies was done by Mosca and de Bot (2017) where they asked 32 Dutch-English bilinguals to complete a lexical decision task and picture naming task. There was an unexpected L1 switching cost for the lexical decision task, and interestingly, for the picture naming task, the authors saw symmetrical switching costs such that the difference between repetition and switch trials was similar for the L1 and L2. These unexpected results may have been the result of picture naming in the L2 being faster than in the L1 (reversed language dominance effect). In the lexical decision task, the authors found that words in the L1 were responded to faster than the L2.

Another study looking at both production and comprehension was Macizo et al.'s (2012) study, where they found an asymmetrical pattern in their Spanish-English bilinguals' L1 switching cost in word naming. The Spanish-English bilinguals were slower in word naming when switching to the L1 compared to when they switched to their L2. However, symmetrical switching costs were observed on the semantic categorization tasks. In line with Macizo et al.'s (2012) results, Jylkkä and colleagues (2018a and 2018b) found similar results in their production and comprehension studies. Jylkkä et al.'s (2018a) study found asymmetrical switching costs with a greater cost for L1 than L2 in their picture naming task. With the same participant group, Jylkkä et al.'s (2018b) found symmetric switching costs in the semantic categorization task.

One explanation for these results was outlined by Macizo et al. (2012) where the authors explain that competition is a prerequisite for inhibition, and that there is less competition for a comprehension task since the activation of an English word like "dog" and its translation equivalent in Spanish (*perro*) will elicit the same response from participants regardless of language, since both "dog" and *perro* are words, animate, and belonging to the animal category.

Comparing the results between production and comprehension studies, we see a couple of patterns: 1) a prevalent L1 switching cost in production studies and 2) wide range of switch costs in comprehension (e.g., absent/symmetrical costs, greater L2 switching cost, greater L1 switching cost, or a mix of results within a single study). These differences may be attributed to the competition in production studies unseen in comprehension studies, where participants are activating the words of both languages for a single picture and mapping a cue to each picture.

While Mosca and de Bot (2017), Macizo et al. (2012), and Jylkkä et al. (2018a and 2018b) all asked participants to complete production and comprehension tasks separately, Peeters et al. (2014) combined tasks by asking French-English bilinguals to name pictures in L1 or L2 depending on block and classify words as L1 or L2 (Task 1) or as animals or not (Task 2). Peeters et al. (2014) found significant L1 switch costs in both tasks when bilinguals were naming pictures in their L1 French. There were no significant L2 picture naming switch costs for these two tasks.

As a follow-up to Peeters et al. (2014), Li and Gollan (2021) conducted a replication study with Spanish-English bilinguals with some modifications to the research design. In their first experiment, participants were asked to name pictures in Spanish language for one block and in English for the second block while naming words in both Spanish and English. Li and Gollan (2021) found an order effect such that bilinguals who completed the dominant language picture-naming block first named pictures faster in their dominant than nondominant language. Interestingly, bilinguals who named pictures in the nondominant language first named pictures equally quickly in their two languages. In their second experiment, Li and Gollan (2021) changed the word naming portion of the previous task to semantic categorization where participants had to decide whether words were animals or not and found asymmetric switching costs with significant switch costs in the L1 but none for the L2 for picture naming.

Li and Gollan (2021) discussed whether language switch costs from comprehension to production reflect a shared language control mechanism or a change between comprehension and production tasks. The authors point out that the difference between production and comprehension is the starting point of processing. For production tasks such as picture naming, concepts are activated first. For comprehension tasks, the first step is the recognition of the orthography.

Another interesting take by Struys et al. (2019) and Jiang (2023) is that production tasks may require domain-general inhibitory control due to the bivalent stimuli used (e.g., pictures, digits) and comprehension relies on a domain-specific control mechanism and involves stimuli coded in a specific language (i.e., univalent stimuli). In addition, the different language switching patterns for production and comprehension may be a result of the top-down and bottom-up processing mechanisms involved, respectively (Declerck & Philipp 2015; Jiang 2023; Mosca & de Bot 2017).

Due to these inherent differences between the production and comprehension tasks used here in this section, it is difficult to directly compare language switching in these studies. Within comprehension, there are studies that used the lexical decision task, animacy judgment, semantic categorization task, or parity task, which require different levels of information processing. It may be valuable to set an environment where a production and comprehension task could be more easily compared, such as a word naming task and lexical decision task, where words are displayed on a screen.

2.4 Role of proficiency

Not many language switching studies have proficiency measures. A few include verbal fluency measures (Ivanova, Seanez, Cochran, & Kleinman, 2022; Schwieter & Sunderman, 2008) or word recognition tests (e.g., von Studnitz & Green, 1997), self-reported proficiency ratings (Declerck et al., 2019; Macizo et al., 2012; Peeters et al., 2014; Philipp et al., 2007, to name a few), vocabulary tests (e.g., Prior & MacWhinney, 2010), or LexTALE scores (Declerck et al., 2019; Struck & Jiang, 2022). In Meuter and Allport (1999), two groups that differed in regards to their relative L1/L2 proficiencies were created using the data from their experimental, numeral naming task. Due to the lack of uniform proficiency measures, comparisons across studies in terms of participant proficiency are difficult to make.

In terms of switching costs, some studies find that highly proficient bilinguals display symmetric switch costs in production (Costa & Santesteban, 2004; Costa et. al., 2006; Schwieter & Sunderman, 2008), while others do not observe the same results (Bonfieni, Branigan, Pickering, & Sorace, 2019 for Spanish-English bilinguals). Costa and Santesteban (2004) were among the first to look into the role of proficiency in language switching where they conducted five experiments on different bilingual speakers with various levels of L2 and L3 proficiencies.

Costa and Santesteban (2004) replicated the Meuter and Allport (1999) experiment but used pictures instead of digits and assigned colors (blue and red) indicating which language to name the pictures in. Costa and Santesteban (2004) improved the Meuter and Allport (1999) study by recruiting homogeneous participant groups per experiment who share the same L1 and L2 and reducing the number of trials (950 trials compared to 2,000 in the Meuter and Allport study). Experiment 1 tested native speakers of Spanish learning Catalan for 1.5 years on average and native speakers of Korean learning Spanish for 4 years on average. Both groups showed asymmetric switching costs with a larger switching cost for L1 compared to the L2.

However, in a follow-up experiment (Experiment 2) with Spanish-Catalan speakers who were highly proficient in their L2, the authors found the opposite results: symmetrical switching costs in L1 and L2. Additionally, these participants named pictures in their L1 more slowly than their L2 (i.e., the reversed language dominance effect). Out of concern for picture repetition in Experiment 1 (95 times per picture), their Experiment 3 included 30 additional pictures which appeared just 23-24 times each throughout the experiment. Despite these changes to the experimental design, Costa and Santesteban (2004) found similar switching costs for both languages (65 ms. for L1 and 60 ms. for L2) as well as slower naming responses in L1 compared to L2 mirroring results from Experiment 2. This symmetrical switching cost was even observed with highly proficient bilinguals completing the task in their L1 and L3 (Experiment 4) and in their L2 and L3 (Experiment 2, Costa et al., 2006).

In addition, similar symmetrical switching costs were observed in Costa et. al (2006) with additional bilingual groups: 1) Spanish-Basque simultaneous bilinguals highly proficient in both languages, 2) Spanish-English sequential bilinguals highly proficient in both languages, and 3) Spanish-Catalan bilinguals highly proficient in their L2 Catalan completing an L2/L3 task. Costa et. al (2006) asserts, based on their findings, that asymmetrical switching costs emerge for participants with low proficiency in a language who are tested in that language. In their Experiment 3, Costa et. al (2006) tested Spanish-Catalan speakers in their L3 English and L4 French finding an asymmetrical switching cost with a greater cost for the L3. Similarly, the authors found that Spanish monolinguals tested in a new, invented language also show asymmetrical switching costs with a greater cost for their L1 Spanish.

Schwieter and Sunderman (2008) were very interested in these results obtained by the two Costa studies and decided to look into possibilities that were briefly introduced by Costa et al. 2006: lexical robustness. Schwieter and Sunderman (2008) decided to replicate the Costa studies using the same pictures from Costa and Santesteban (2004) but added a verbal fluency measure (i.e., to operationalize lexical robustness and determine L2 lexicon size). In their study, the verbal fluency scores ranged from 56 to 220. The authors found a similar pattern of asymmetrical switch costs with a greater switch cost going from L2 Spanish to L1 English. There was also a significant interaction between verbal fluency score and the effect of switching, such that for bilinguals with the lowest verbal fluency scores (around 50), the switching cost was quite large with English taking approximately 40 ms. longer compared to Spanish. Those with a higher verbal fluency score of 110, the switching cost appears to be symmetric. Thus, the authors believe that lexical robustness plays a role in bilingual switching and developed a Selection by

Proficiency Model (SbP), where less proficient and highly proficient differ in terms of how they name pictures.

According to the SbP, the conceptual and lexical links are stronger for highly proficient L2 bilinguals compared to the less proficient L2 bilinguals and assumes that inhibitory control is necessary for the less proficient L2 bilinguals during language switching. The idea that the links between L2 words and concepts are weaker than the L1 is a sentiment shared by the RHM (Kroll & Stewart, 1994), where L2 concepts are associated with their L1 lexical item first. Since less proficient bilinguals are hypothesized to use their L1 to access L2 words/concepts, inhibition is required to suppress their L1 in the process. Schwieter and Sunderman (2008) urge other researchers to use continuous proficiency measures rather than less informative measures, such as categorical groupings to test the SbP.

In more recent studies with separate and continuously scored proficiency measures, symmetrical switching costs were observed for Hebrew-English, Mandarin-English, and Spanish-English participants in a digit naming task (Prior & Gollan, 2013). Symmetrical switching costs were also observed in Bonfieni et al.'s (2019) picture naming task with their Italian-Sardinian bilinguals. Larger switching costs into the L2, however, were observed in Bonfieni et al.'s (2019) Italian-English bilinguals who were considered less balanced in terms of L2 language proficiency than the Italian-Sardinian bilinguals.

An example of the importance of background proficiency/language variables can be observed in a recent study by Han, Li, and Filippi (2022) where Mandarin-English bilinguals who use languages separately in different contexts were more likely to produce greater RT switch costs to Chinese in the language switching task. In fact, there was a significant correlation between participants’ frequency of contextual switching and L2 English to L1 Chinese switching in the picture naming task.

All the studies above involved production-based tasks and for the most part involve digits/pictures with a cue. There are only a handful of production studies which involve the naming of visual words. Studies by Filippi, Karaminis, and Thomas (2014) and Macizo et al. (2012) are a couple relevant examples, and interestingly, both found results in line with Meuter and Allport (1999) and Costa and Santesteban (2004) studies where there were larger switching costs when naming in the L1. Also, the switching cost appeared to be larger when L2 proficiency was lower for Filippi et al. 2014 only. Peeters et al. (2014) was another study that avoided the use of cues by implementing blocks where pictures were always named in the one language with words from both languages interleaved throughout. As a whole, there seems to be a clear pattern in the production-based studies that seems to be replicated in a variety of studies where participants who are highly proficient in both languages seem to be able to switch between L1-L2 and L2-L1 trials in a symmetrical manner.

For comprehension, Struys et al. (2019) found that the L2 switching cost in their semantic categorization task correlated with L2 exposure but not any of their other language measures (e.g., self-rated L2 proficiency and L2 verbal fluency). In other words, participants with higher levels of recent exposure to their L2 French showed smaller switching costs from the L1 Dutch to L2 French compared to those with lower exposure to L2 French. However, in Jylkkä et al. (2018b), no relationship between proficiency (as measured by an LDT) and switching costs (in their semantic categorization task) were found. However, the lack of significant correlations between proficiency and their comprehension task could be due to the type of proficiency measure used in Jylkkä et al. (2018b). The validity of LDTs, such as LexTALE (Lemhöfer and

Broersma, 2012), as global L2 proficiency measures have been under question recently (Nakata, Tamura, & Aubrey, 2020; Puig-Mayenco, Chaouch-Orozco, Liu, & Martín-Villena, 2023).

Altogether, proficiency does seem to play a role in language switching, but it is yet unclear in what systematic ways proficiency is involved in language switching. A somewhat recent meta-analysis by Gade, Declerck, Philipp, Rey-Mermet, and Koch (2021) on asymmetrical switching costs compared a meta-analytic model with and without a proficiency ratio and found that the model that included the proficiency ratio fit the data better. However, the proficiency ratio was computed by the authors and was based on self-assessed language proficiency data from 73 journal articles. Furthermore, there appears to be evidence in favor of language experience (especially switching between languages frequently in daily life or L2 exposure) modulating smaller language switching costs as seen in Prior and Gollan (2011) and Bonfieni et al. (2019).

2.5. Valence and the role of language script

Stimulus valence refers to the number of languages that can be used to name/respond to a certain stimulus. Some language switching studies have artificially manipulated valence by instructing participants to name pictures and/or digits in a certain language by block or depending on a cue (Finkbeiner et al., 2006; Li & Gollan, 2022; Peeters et al., 2014), but pictures and digits are inherently bivalent stimuli, since they can be named/responded to in more than one language. In addition to pictures and digits, certain words that share form and/or meaning across languages, such as cognates and interlingual homographs are also considered bivalent (Christoffels et al., 2007; Filippi et al., 2014).

However, when two languages distinctly differ in script or orthographic cues, the words of those two languages are considered univalent. For univalent stimuli, no additional language cue such as a shape, color, or flag, for example, is needed in a task. Thus, language switching data does not become contaminated with cue-language mapping processes with univalent stimuli. Furthermore, univalent stimuli may offer a processing advantage for participants through the script and orthographic cues provided and could ease the identification of the appropriate language and ultimately facilitate the lexical decision-making process (for lexical decision tasks) or the semantic categorization process (for semantic categorization tasks).

Slevc, Davey, and Linck (2016) were interested in comparing language switching performance with English words and Chinese characters (inherently univalent stimuli) and English words and Chinese *Pinyin* (bivalent stimuli) in a word naming task. Slevc et al. (2016) found symmetrical switch costs for the univalent English and Chinese characters block as well as the bivalent English and *Pinyin* block, which they use to support the idea that language switching costs are not tied to the stimulus valence (Finkbeiner et al., 2006). However, the absence of an asymmetrical switching cost in this study may be due to the lack of competition necessary to complete the task, since participants are reading and naming words without needing to retain cue information or map cues onto stimuli. Finally, *Pinyin* often uses diacritic markers to denote tone, and I wonder whether an orthographic cue such as diacritic markers would create an environment where English words and Chinese *Pinyin* are more univalent than bivalent. Unfortunately, there are not many studies looking at the role of valence especially with languages that share and do not share a script.

In terms of phonological similarity, Declerck and Philipp (2015) found that for their picture naming task with English-German bilinguals, there were symmetrical switching costs in the “no phonological overlap” condition. However, for the “phonological overlap” condition, switching costs were asymmetrical with larger L1 switch costs (179 ms.) compared to L2 switch costs (32 ms.). In addition to phonological overlap, orthographic overlap has also been investigated in a language-exclusive lexical decision task by Orfanidou and Sumner (2005), where language specific and language non-specific conditions were created. Greek-English bilingual participants had to decide whether a word on the screen was a word or not based on the language cue provided. The conditions were created such that some words were possible in one language but not the other (language-specific) and some words could be possible in both (language non-specific). The switching cost was reduced for stimuli with language-specific orthography compared to non-specific orthography in the first experiment where the language switching sequence was predictable.

In addition, another study by Guo and colleagues (Guo, Liu, Chen, & Li, 2013) found that there were different n-2 repetition costs for Uighur-Chinese-English trilinguals depending on the type of cue used (language or graphic cue) with a greater cost under the graphic cue compared to the language cue condition, suggesting that the language cue may have activated the target language more successfully than the graphic cue. In terms of orthography, the differences among Uighur, Chinese, and English writing systems are very clear, which may have resulted in this smaller n-2 repetition cost for the language cue condition. However, despite some clear patterns (namely that closely related languages or language features seems to create more interference), research on language distance/similarities is limited. In a more recent study by Kang, Ma, Li, Kroll, and Guo (2020), no interaction between language (English/Chinese) and type of trial (switch/non-switch) was found in their picture naming task indicating symmetrical switching costs in English and Chinese.

With regards to the languages studied in language switching, most of the languages are those that share a script and are typologically similar (e.g., English, Spanish, French, Dutch, etc.)

Looking at Table 1 in Gade et al. (2021) where they list the 73 production studies they included in their meta-analysis, 24 studies (33%) used languages where the orthographies and language families are different (e.g., Chinese/English, Swiss German/Tamil, Hebrew/English, to name a few). Not many studies have looked into whether there are differences in language switching patterns between orthographically/typologically similar (e.g., French-English) and dissimilar languages (e.g., Persian-English), but one such study was done by Radman, Jost, Dorood, Mancini, and Annoni (2021) where they compared bilinguals whose languages were "Close Language Pairs" and "Distant Language Pairs." The researchers found an asymmetric switching cost into the more dominant L1 than weaker L2 in the "Close Language Pairs" group only, and a symmetric switching cost for the bilinguals whose languages are distant pairs. According to Radman et al. (2021), this difference is due to less competition between L1 and L2 representations for the bilinguals whose languages are distant pairs.

2.6. Limitations of previous studies

Regarding language switching research, there are a few primary limitations and gaps in this area that will be addressed in the following sections, such as the issue of artificial cue-based switching; non-uniformity in research design, tasks, and participants; small sample sizes and limited scope of languages studied; and the fact that there are a number of models but no systematic theory or hypothesis that can account for the differences between language switching in production and comprehension or can explain the wide pattern of results observed in language switching.

2.6.1. Artificial switching and lack of natural, orthographic cues

Most of the production studies described in this literature review used artificial switching with a color or flag cue. Regardless of whether bilinguals are naming digits or pictures, cues are required to prompt bilinguals to name the digit or picture. In addition, some of the cues (e.g., graphic shapes) were complex such that mental load issues could be expected for participants. Or, in some studies, the over repetition of digits and pictures may have led to artificial switching costs. Digits and pictures are bivalent stimuli, which means that they can be uttered/processed by bilinguals in both of their languages. Slevc et al. (2016) emphasize that there has been little research with language switching and univalent stimuli, such as language-specific orthography, which is problematic.

The use of bivalent stimuli in combination with language cues could introduce a great deal of noise in language switching data, since a participant's performance is not only affected by language switching itself but also by how well they can remember the cue and the associated language to use. In contrast, where univalent materials are used, the orthography of the language automatically indicates which language is to be used.

It is unclear whether switching costs and the asymmetrical patterns in production (L1 switching cost) reflects language switching or the cued task that is frequently used (Peeters et al., 2016; Gollan & Ferreira, 2009). In fact, Gollan and Ferreira (2009) found symmetrical switch costs or no switch costs at all for their voluntary or quasi-voluntary language switching experiments where participants could decide when to switch between their two languages.

There appears to be an increase in the number of studies investigating voluntary (i.e., no cue) versus involuntary (i.e., with a cue) language switching (de Bruin & Xu, 2023; Jevtović, Duñabeitia, & de Bruin, 2020; Mooijman, Schoonen, Ruiter, & Roelofs, 2023) with most but not at all showing larger switch costs for the involuntary, cued tasks than the voluntary tasks without a cue.

2.6.2. Non-uniformity in research design, tasks, and participants

Across this literature review, there are clear differences in research design, tasks, and participant groups. While there are a handful of replication studies (for example: Schwieter & Sunderman 2008 was a replication of Costa & Santesteban 2004; Li & Gollan 2021 was a replication of Peeters et al. 2014; and Fink & Goldrick 2015 was a replication of Verhoef et al. 2009), slight differences in research design leads to differences in results between studies and within studies, such as the manipulation of cue stimuli presentation time (Costa & Santesteban, 2004; Ma, Li, & Guo, 2016; Philipp et al., 2007; Verhoef et al., 2009), alternating/predictable sequencing (Ong et al., 2019; Orfanidou & Sumner, 2005), or use of precues (Verhoef, Roelofs, & Chwilla, 2010).

Also, it is clear that not all participant groups are homogeneous across this research area. Some studies have participants with the same L1 and different L2s, while others make efforts to ensure that their groups are homogeneous by using additional tasks, such as proficiency tests. When the participant groups change experiment to experiment, direct comparisons between groups are difficult to make. Even within studies, experiments are manipulated in such a way that comparisons across experiments within a study are difficult to reconcile.

An example of the variation in language switching studies is the number of items in one language versus the other. Timmer, Christoffels, and Costa (2019) were interested in manipulating the context of a picture naming task into 1) dominant L1 context with 83% of the filler pictures in Dutch, or 2) non-dominant L2 context with 83% of the filler pictures in English.

The authors found symmetric switching costs in the L1 Dutch context and asymmetric switching costs with larger costs for the L2 in the L2 English context.

Review articles and chapters (Bobb & Wodniecka, 2013; Declerck & Philipp, 2015; Gade et al., 2021; Jiang, 2023) also note these issues by describing the different participant groups, possible modulating variables, and varying task design/manipulations.

2.6.3. Small sample sizes and limited scope of language

Many of the studies in this literature review have small *n* sizes. Table 1 includes some of the studies referenced and the number of participants per study. Note that Table 1 does not contain all studies, but provides a glimpse of the participant sizes in some of the studies from the late 80's to 90's to the more recent years. Participant *n* sizes appear to have increased over time with some recent studies testing 30-40+ participants (Bonfieni et al., 2019; Han et al., 2022; Struys et al. 2019, for example) to 50-60 (Linck, Schwieter, & Sunderman, 2012; Prior & Gollan, 2013; Slevc et al., 2016) and over 100 (Struck & Jiang, 2022).

Looking at Table 1, it is clear that many of the early studies did not have uniform participant groups that share a single L1 and L2. Also, a quick glance at the select studies in Table 1 suggest that the majority of language switching studies are those that share the Roman/Latin alphabet (although exceptions are Mandarin-English and Greek-English).

Table 1. Participant n sizes in language switching studies.

Task type	Languages	Study	*n* size
Production	Varying L1-Varying L2	Meuter and Allport 1999	16
	English-Varying L2	Jackson et al. 2001	20
	English-Varying L2	Finkbeiner et al. 2006	16
	German-English	Philipp et al. 2007	18 (Exp. 1)
	Varying L1-English	Fink and Goldrick 2014	14
	Mandarin-English	Han, Li, Filippi 2022	31
Comprehension	French-English	Grainger and Beauvillain 1987	16
	German-English	von Studnitz and Green 1997	20 (Exp. 1)
	English-French	Thomas and Allport 2000	16 (Exp. 1)
	Greek-English	Orfanidou and Sumner 2005	24
	French-English	Aparicio and Lavaur 2014	12 (Exp. 1)
	Dutch-French	Struys et. al 2019	32

2.6.4. No universal model for language switching

Overall, looking at all the theories and hypotheses related to language switching in bilinguals, it is challenging to bring them all together and build a comprehensive theoretical account of bilingual language switching, especially when studies on this topic are not exactly uniform in terms of participants, experimental design, and procedures. Abutalebi and Green (2008) state that “no model accounts transparently for the full range of behavioural data.” (p. 562) in language switching.

In an effort to create a unified model of language control, Green and Abutalebi (2013) proposed the adaptive control hypothesis where language control processes adapt based on the interactional context. They specify eight different control processes (goal maintenance, conflict monitoring, interference suppression, salient cue detection, selective response inhibition, task disengagement, task engagement, opportunistic planning) and three interactional contexts (single language, dual language, and dense code-switching) in their hypothesis, which was developed with a focus on bilingual speech production. The authors described that different contexts require different control processes with the dual language context (where both languages are used but with different speakers and within a conversation) requiring 7 out of 8 control processes. An issue with this hypothesis is the limits on interactional contexts (only three) as well as the role of individual differences. Green and Abutalebi (2013) point out that “the relationship between proficiency and specific adaptive changes as a function of interactional context is unlikely to be straightforward” (p. 525) and the assumption for their hypothesis is that the bilinguals are highly proficient in both their languages.

2.7. Motivation of the current study

No study to date has uniformly compared the production and comprehension in a single study using naturalistic (i.e., non-cued) word visual display shared across both tasks. While there are studies looking at production and comprehension (Jylkkä et al., 2018a; Jylkkä et al., 2018b; Li et al., 2024; Macizo et al., 2012; Mosca & de Bot, 2017) and together in a single task (Li & Gollan, 2021; Peeters et al., 2014), the tasks used to measure language switching in production and comprehension are different and not comparable. For example: naming a picture/word based on a given cue and categorizing a picture/word based on its semantic features are extremely dissimilar tasks requiring different steps and processes for bilinguals. Li et al. (2024) may be the closest in design to the current study, but theirs was a between-subjects design such that one group completed the comprehension task and the other group completed the production task. In addition, while the materials were shared between tasks, the visual presentation differed for the comprehension task (paragraph silent reading) and the production task (words read one by one aloud).

For the current study, participants will see one word on the screen at a time and either name the word or decide whether that word exists in Korean or English. We expect no mental load issues, unlike previous studies which required multiple tasks in one and/or the integration of multiple sources of information in a single trial. Furthermore, not many studies have looked at switch costs with and without orthographic cues. Those that have include Orfanidou and Sumner (2005), Slevc et al. (2016), and Thomas and Allport (2000). However, these studies are all limited to a single task type (comprehension or production).

In the case of Korean, there are three writing systems: *Hangeul*, *Hanja* (Chinese characters), and Korean romanization. Although *Hanja* (Chinese characters) was the first writing system used in Korea, *Hangeul* is the most prevalent writing system used in Korea today. While *Hanja* (Chinese characters) is still taught in schools, its current use is limited to only certain vocabulary in occasional newspapers and scholarly books and for recording Korean given and last names in government documents. *Hangeul,* on the other hand, is a writing system developed for the Korean language and comprised of consonant and vowel symbols, which are then combined into syllable blocks. In a single syllable block, a consonant symbol is first then followed by a vowel (or diphthong) then a consonant symbol if needed in a left to right and top to bottom order (Sohn, 1999). In regards to Korean romanization, there are many existing systems (e.g., McCune-Reischauer, Yale romanization, etc.), but as of 2000, the government (National Institute of Korean Language) considers the Revised Romanization of Korean as the official Korean language romanization system. The romanization system is frequently used in signs (e.g., subway stops) but is not taught in schools in South Korea like *Hangeul* and *Hanja* are.

In this study, *Hangeul* will most likely immediately cue participants to name and evaluate words in Korean, but the Revised Romanization of Korean may not cue participants in the same way or may delay the language cue to participants. Will participants be able to recognize and switch between languages easier with different or shared orthography? Will the

Korean romanization make it more challenging for Korean-English bilinguals to decode words? The majority of the studies described in the literature review involved languages that do share a script. Regarding familiarity, the Korean-English bilingual participants should be able to access *Hangeul* and English words on the screen, but may be less familiar with the Revised Romanization of Korean.

We are specifically interested in Korean-English bilinguals to determine whether switch costs are symmetric or asymmetric in a mixed language naming task and a language inclusive lexical decision task to better understand the role of valence and orthography in language switching in production and comprehension. This study also includes extensive language background questionnaires and proficiency tests, which has been missing in previous language switching studies. While previous findings suggest that proficiency plays a role in how well bilinguals are able to switch between their languages, the way proficiency is measured in these studies are not uniform and are oftentimes more qualitative than quantitative or subjective rather than objective assessments.

2.7.1. Research questions

The present study aims to address the following three research questions:

1. What differences, if any, are there between the production and comprehension task specifically in regards to word processing, magnitude of switching costs, and presence of asymmetry?
2. What role does proficiency play in language switching?
3. What role does orthography and orthographic cues play in language switching? Specifically, how do switching costs compare between the *Hangeul a*nd the Korean romanization tasks?

For the first research question, based on previous findings, we can predict larger switch costs for the production task compared to the comprehension task, since participants are engaged in the active selection of language in a production task. For the present study, we used a word naming task to measure language switching in production and a language inclusive lexical decision task to measure language switching in comprehension.

Based on previous studies, we would most likely expect an asymmetrical switching cost with a larger switch cost from the L2 English to L1 Korean for the production task. For the comprehension task, we may see either an absence of asymmetry such that L1 and L2 switching costs are comparable, or the absence of the L1 switching cost readily observed in production studies. If our production and comprehension results are comparable to these previously observed patterns, we can suppose that any cue-language mapping was a non-issue in previous studies. However, if a different pattern of results emerges in the present study, we may be able to provide supporting evidence for this pattern of results potentially being a result of cue-language mapping issues. Regarding production and comprehension tasks, we expect longer RTs for the production task which requires processing and verbalizing words, especially for the romanization experiments.

Regarding the role of proficiency, we may see that highly proficient bilinguals will show symmetrical switch costs in one or both of the tasks. A proficiency explanation may potentially override the inhibition explanation if we see highly proficient Korean-English bilinguals showing symmetrical switching costs in both production and comprehension compared to those who are less proficient. To test the role of proficiency, it will be necessary to recruit Korean-English participants of varying proficiencies and language background histories. For this study, we are administering two proficiency tests: an English cloze test and English Elicited Imitation Task (EIT) as well as a comprehensive language background questionnaire.

For the final research question, according to the BIA+ model (Dijkstra & van Heuven, 1998), there should be a smaller switching cost in both comprehension and production between *Hangeul* Korean and English due to the orthographic cues and nodes. There should be less coactivation of Korean and English with *Hangeul* due to the distinct difference in orthography. Along the same vein, we should expect greater switching costs with Korean romanization due to the processing of the same Latin/Roman script. Processing words from the L2 to L1 and vice versa may be more effortful when the script is shared. A more asymmetrical switching cost for the Korean romanization experiments is predicted compared to the bilinguals assigned to the *Hangeul* experiments due to the greater processing required to read words from different languages in the same, shared script.

By keeping the comprehension and production task display similar in the present study (i.e., words on the screen), language selection should be input-driven and based on orthography for both naming and the lexical decision tasks. Using univalent stimuli, such as *Hangeul* and Revised Romanization, we will be able to isolate genuine switching costs and make direct comparisons between comprehension and production. Furthermore, any differences between performance on the *Hangeul* and Korean romanization experiments could possibly elucidate previous results which focused mostly on bilinguals who share a script or whose languages are typologically similar.

Chapter 3: Language switching in Production

3.1 Study Overview

To examine language switching in production among Korean-bilinguals, a bilingual naming task was developed. One group completed the task in *Hangeul* and English, and the other group completed the task in Korean romanization and English (i.e., between-subjects design). The purpose of this specific naming task was to see how Korean-English bilinguals switch between Korean and English and vice versa in production when Korean words were presented in *Hangeul* versus Korean romanization. Participants also completed a language inclusive lexical decision task to measure language switching in comprehension, a language background questionnaire, and English proficiency tests: English cloze test and English Elicited Imitation Task (EIT). Participants who completed the naming task in *Hangeul* and English also completed the bilingual lexical decision task in *Hangeul* and English. Likewise, participants who completed the naming task in Korean romanization and English also completed the bilingual lexical decision in Korean romanization and English. Only participants who were 70% or higher in accuracy on both their production and comprehension tasks were included in this chapter on production and the following chapter on comprehension.

3.2. Methods

3.2.1. Participants

Korean-English bilinguals living in the United States were recruited through various means such as Facebook, LinkedIn, Prolific, hard copy flyers, and word of mouth. A total of 108 participants recruited for this study completed the two main tasks: naming task and lexical decision task. For the *Hangeul*-English naming task, 53 L1 Korean L2 English bilingual participants completed the task successfully; however, three of the 53 participants experienced issues with their microphones, which resulted in audio recordings that were not audible. Out of the remaining 50 participants in the *Hangeul* group, one performed under 70% on their comprehension task, so their production data was also removed for a total of 49 participants in the *Hangeul* group. Among the 49 participants in the *Hangeul* group, one participant's EIT data was not available due to audibility issues.

For the Korean romanization naming task, audio recordings were available from a total of 54 out of the 55 L1 Korean L2 English bilingual participants who completed both tasks. However, only 26 of the 54 participants performed over 70% accuracy on their comprehension task, so only their production data was included in these sections. The 28 participants who obtained lower than 70% accuracy on the comprehension task were excluded from further analyses. Among the 26 participants in the Korean romanization group, one participant's cloze data was not available since that participant skipped that proficiency measure.

Out of the 49 participants who participated in the *Hangeul* task, 39 were female, 9 were male, and 1 identified as non-binary. Out of the 26 participants who participated in the Korean romanization task, 16 were female and 10 were male. Details on the 75 participants' mean age of acquisition, mean length of residence in an English-speaking country, and their mean English proficiency test scores can be found in the table below. More details on the language background questionnaire and English proficiency measures will be described in the Materials section of this chapter. In terms of missing data, one participant did not have EIT data; one participant did not have cloze test data; and five participants did not have length of residence information. All participants were able to provide their age, age of acquisition for English, and self-reported proficiency in English.

Table 2. Language background and proficiency of the Korean-English bilingual participants.

Hangeul grp (n = 49)	Age	Age of acquisition (L2 English)	Length of residence (in US)	English cloze test (out of 50)	English Elicited Imitation (out of 120)	Self-reported proficiency (out of 10)
Mean	28.59	7.60	40.14	32.94	97.00	7.35
SD	6.33	3.46	45.56	9.09	14.28	1.48
Minimum	19	0.00	1.00	7.00	68.00	4.00
Maximum	43.25	22.00	168.00	47.00	117.00	10.00
Romanization grp (n = 26)						
Mean	30.88	8.14	125.55	39.76	104.54	8.54
SD	8.62	3.49	97.31	6.27	9.55	1.53
Minimum	20.67	1.00	1.00	21.00	82.00	5.00
Maximum	57.00	15.00	345.36	49.00	118.00	10.00

Multiple Wilcoxon rank sum tests were run to test the differences between the two groups with significant differences on all characteristics except age ($W = 557$, $p > .05$) and age of acquisition ($W = 571.5$, $p > .05$). However, if we compare the differences between the *Hangeul* group and the initial 55 participants who completed the naming task in Korean romanization, there are more similarities between groups. For example, there is no statistically significant difference between the groups on their English Elicited Imitation task performance, $W = 1311.5$, $p > .05$ suggesting that the initial groups are equal in expectation and similar in terms of their English language proficiency despite these two groups' different lengths of residence in an English-speaking country ($W = 581$, $p < .001$) and their self-reported proficiency ($W = 927$, $p < .05$).

All 75 participants reported that Korean was their first language. Only one participant assigned to the *Hangeul* group said that it was both Korean and English. All 75 participants reported that their mother's native language and father's native language was Korean. Participants were asked which language they feel most comfortable speaking in casual conversation. For the *Hangeul* group, all but one participant answered Korean as the language they feel most comfortable speaking in. Interestingly, for the Korean romanization group, while more than half (14 out of 26 participants) answered Korean as the language they feel most comfortable speaking in, 3 answered that it was both languages and 9 answered English. This between-group difference in language proficiency and dominance may be evidenced by the statistically significant differences between groups on the Elicited Imitation Task ($W = 437$, $p < .05$) and cloze test scores scored via the acceptable ($W = 331$, $p < .01$) and exact ($W = 342.5$, $p < .01$) scoring methods.

Participants were also asked about which language(s) they used in certain situations. Table 3 has information on their language choices in various situations. Multiple Wilcoxon rank sum tests were run to test the differences between the two groups. There were statistically significant differences between groups in terms of language choice at home ($W = 817$, $p < .05$), at work ($W = 583$, $p < .05$), social activities such as hanging out with friends ($W = 823$, $p < .05$), extracurricular activities such as hobbies, sports, and volunteering ($W = 642$, $p < .01$), watching movies ($W = 854$, $p < .01$) and TV ($W = 836$, $p > .05$), listening to radio/music ($W = 782$, $p < .05$), and browsing the internet ($W = 862$, $p < .01$). There were no statistically significant differences between groups in regards to language choice at school ($W = 697$, $p > .05$), religious activities such as church, public/banks/government/healthcare/private offices ($W = 211$, $p > .05$), reading ($W = 671$, $p > .05$), emailing ($W = 792$, $p > .05$), texting ($W = 777$, $p > .05$), social media ($W = 767$, $p > .05$), and writing ($W = 803$, $p > .05$). This means that the *Hangeul* group used more Korean at home, at work, and in social activities and extracurricular activities. The *Hangeul* group also used Korean more for watching movies and TV, listening to radio/music, and browsing the internet.

Table 3. Language choice in various situations.

	Hangeul group (*n* = 49)				Korean romanization group (*n* = 26)			
	Mean	*SD*	Min	Max	Mean	*SD*	Min	Max
Home	4.20	1.21	1.00	5.00	3.81	1.06	1.00	5.00
School	1.94	1.05	1.00	5.00	1.46	0.59	1.00	3.00
Work	2.08	1.42	1.00	5.00	1.27	0.77	1.00	4.00
Social activities	3.02	1.09	1.00	5.00	2.42	1.03	1.00	5.00
Religious activities	3.92	1.32	1.00	5.00	3.23	1.09	2.00	5.00
Extracurricular activities	3.03	1.44	1.00	5.00	1.86	1.08	1.00	4.00
Public/private and govt offices	1.92	1.52	1.00	5.00	1.39	1.02	1.00	5.00
Reading	2.80	1.12	1.00	5.00	2.65	0.94	1.00	4.00
Emailing	2.14	1.08	1.00	5.00	1.65	0.69	1.00	3.00
Texting	3.18	0.86	1.00	5.00	2.85	0.78	1.00	4.00
Social media	3.45	0.83	2.00	5.00	3.00	0.75	1.00	4.00
Writing	2.59	1.22	1.00	5.00	2.04	0.82	1.00	4.00
Watching TV	3.70	1.02	1.00	5.00	3.04	0.82	1.00	5.00
Watching movies	3.31	1.11	1.00	5.00	2.62	0.70	1.00	4.00
Listening to radio/music	3.06	0.90	1.00	5.00	2.60	0.65	1.00	4.00
Browsing the internet	3.22	0.82	2.00	5.00	2.65	0.69	1.00	4.00

Rating scale: 1 = All English, 2 = Mostly English, 3 = Half English Half Korean, 4 = Mostly Korean, 5 = All Korean

The participants were also asked about their tendency to switch languages during a conversation and if there were certain situations or topics/issues where they normally switch between their two languages. A comparison of participant answers by question can be found in Table 4.

Table 4. Language switching questions.

	Hangeul group (n = 49)		Korean romanization group (n = 26)	
Questions	Mean	*SD*	Mean	*SD*
Q1. I tend to switch languages during a conversation (For example: I switch from Korean to English, or vice versa)	3.14	0.94	3.27	0.92
Q2. There are situations in which I always switch between the two languages.	1.47	0.50	1.54	0.51
Q3. There are certain topics or issues for which I normally switch between two languages.	1.63	0.49	1.77	0.43

Rating scale for Q1: 1 = always, 2 = frequently, 3 = occasionally, 4 = very infrequently, 5 = never
Rating scale for Q2-3: 1 = yes, 2 = no

Multiple Wilcoxon rank sum tests were run to test the differences between the two groups. Interestingly, there were no significant differences between groups on how the Hangeul group answered the three questions in Table 4 compared to the Korean romanization group. Both groups tended to switch languages during a conversation occasionally (W = 571, p > .05). Both groups answered similarly on the questions regarding switching between the two languages depending on the situation (W = 593, p > .05) or the topic/issue (W = 550, p > .05).

3.2.2. Materials

For the naming tasks, 100 frequent and common English and 100 Korean words were selected. All words were disyllabic nouns, and efforts were made to match the English and Korean words in terms of word frequency rank using the Corpus of Contemporary American English (Davies, 2008) and Frequency Dictionary of Korean (Lee, Jang, & Seo, 2016). There is no overlap in meaning between the English and Korean lists, such that all 200 words in the naming task are unique. Four additional English words and four additional Korean words (for a total of eight practice items) were presented in the beginning of the task as practice trials, and participants were asked to name words as quickly and accurately as possible.

The English words were selected by utilizing the *Browse* function in Corpus of Contemporary American English and finding the most frequent disyllabic nouns (in the frequency rank range of 126-1024). The Korean words were selected by using the Noun index from Lee et al.'s 2016 frequency dictionary (in the frequency rank range of 123-1043). See Table 5 for the mean frequencies and rankings of words that were used in the task by language.

Table 5. Descriptive statistics of the Korean and English words in the naming task.

Language	Mean word frequency	Mean word rank
English	213.71 (*SD* = 198.17)	608.51 (*SD* = 241.21)
Korean	392.50 (*SD* = 271.98)	586.53 (*SD* = 244.02)

For the naming task, two lists (List A and List B) were created for counterbalancing purposes such that half of the English words and half of the Korean words were presented in switch trials on one list. In the other list, those same words were presented in nonswitch trials. See Appendix 1 for the full list.

In regards to list ordering, the maximum number of switch trials in a row were three, and there are only four instances of three switch trials in a row throughout the naming task. In addition, the maximum number of words in a given language in a row was three. The languages were alternated in a way that participants would not be able to predict when switching occurs. For both lists, there were 16 instances of three English words in a row and 15 instances of three Korean words in a row. The sequencing of language (Korean/English) and switch type (switch/nonswitch) were identical across lists.

The Korean romanization version of the naming task was identical to the Korean *Hangeul* version described above. The romanization used in the romanization version of the naming task followed the country's official language romanization system, the Revised Romanization of Korean. In regards to letter counts, below is the breakdown of word lengths in Table 6. Efforts were made to match the letter counts between the 100 English words and 100 Korean romanization words.

Table 6. Count of word lengths in English and Korean romanization.

Length	English word count	Korean romanization word count
4 letter words	3	3
5 letter words	20	20
6 letter words	43	43
7 letter words	21	21
8 letter words	11	11
9 letter words	2	2
Total	100	100

Target words remained on the screen for 1.5 seconds similar to the Filippi et al. 2014's word naming study. Data was excluded from the RT analyses if participants misread or failed to read the words displayed on the screen. Gorilla Experiment Builder (www.gorilla.sc) was used to create and host the naming task (Anwyl-Irvine, Massonnié, Flitton, Kirkham & Evershed, 2020). Data was collected between April 2024 and December 2024. Chronset (Roux, Armstrong, & Carreiras, 2017) was utilized to obtain speech onset times for all the individual words. However, sound files were checked manually with Praat software (Boersma & Weenink, 2010) to check the auto-generated speech onset times and for any errors in participant speech production.

The language background questionnaire used in this study was adapted from questions from the Language Experience and Proficiency Questionnaire (Marian, Blumenfeld, & Kaushanskaya, 2007), Bilingual Switching Questionnaire (Rodriguez-Fornells, Kramer, Lorenzo-Seva, Festman, & Münte, 2012), and the Language and Social Background Questionnaire (Anderson, Mak, Keyvani Chahi, & Bialystok, 2018). The full background questionnaire is available as part of the appendices.

To test participants' language proficiency in their English, two L2 proficiency measures were administered. Participants completed the EIT in English (Ortega, Iwashita, Norris, & Rabie 2002) as well as an English cloze test (Brown 1980). The EIT measures general oral and global language proficiency (Isbell & Son, 2021; Kostromitina & Plonsky, 2021). For the EIT, 30 sentences ranging from seven to 17 syllables are played to participants one sentence at a time. After each sentence, participants listen for a tone and are asked to repeat the sentence as accurately as possible. The sentences become progressively longer over the course of the task. Participants' responses are audio-recorded and scored on a scale of 0 to 4 for a total possible score of 120.

A description of the scoring scale is below:

4: sentence was repeated exactly with no errors

3: sentence's meaning was preserved but minor grammatical or lexical changes occurred

2: sentence deviated in meaning from the original

1: sentence deviated substantially in meaning

0: zero to two content words were repeated

A full list of the sentences for the English EIT can be found in Appendix 3. Participants' sentences were transcribed and rated by a native speaker of English, and 10% of all participants were checked by a second rater. After discussions regarding scoring between the first and second rater took place, there were ultimately no differences in scoring found between the two raters for an interrater reliability of 100%.

In addition to the EIT, English cloze test by Brown (1980) was also administered as a written L2 proficiency measure. Using the answer key available, each item on the English cloze test was scored as acceptable/correct (1 point) or unacceptable/incorrect (0 points). The sum of acceptable responses and the sum of correct responses were calculated. Brown and Grüter (2020) recommended using the acceptable/unacceptable sum score if the researcher group had a low L2 English proficiency or a wide range of scores of which the latter was the case in this study. Also, looking at the Pearson's correlations between the two scoring methods for the cloze test and the EIT, the correlation between EIT and the acceptable/unacceptable scoring method was larger in magnitude, $r(72) = .56$, $p <.001$ than the correct/incorrect (i.e., exact) scoring method, $r(72) = .46$, $p < .001$. Thus, the cloze test scores described in Table 2 were based on the acceptable/unacceptable answer key.

However, one particular issue with the cloze test was that participants could spend as long as they wanted on the cloze test, or as little as they wanted to. The cloze test did not have a timer on it. On the other hand, for the EIT, participants were prompted to repeat the sentences after the beep and everyone spent the same amount of time completing the EIT. To check the reliability of the cloze test and the EIT, a split-half correlation using odd items and even items was run. Using the acceptable scoring method, there was a statistically significant correlation between the odd and even items on the cloze test, $r(73) = .83$, $p <. 001$. The Spearman-Brown corrected reliability between the acceptable odd and even items on the cloze test was .91. There was also a statistically significant, stronger correlation between the odd and even items on the EIT, $r(72) = .89$, $p < .001$. The Spearman-Brown corrected reliability between odd and even items on the EIT was .94. Based on these split-half correlations within EIT and within the cloze test scores, EIT proficiency will be used as the proficiency measure in subsequent analyses.

Additional support for EIT as the best measure for proficiency in this study is evidenced by a moderate/strong correlation between EIT and overall self-reported proficiency in English for participants in this study, $r(72) = .55$, $p < .001$. The correlation between cloze test scores (scored via the acceptable scoring method) and overall self-reported proficiency in English was only moderate, $r(72) = .30$, $p < .01$. Looking at language background questionnaire variables, such as length of residence and age of acquisition, the correlation between EIT and length of residence in months was only moderate, $r(67) = .30$, $p < .05$. In addition, the correlation between EIT and age of acquisition (years) was again moderate as well, $r(72) = .32$, $p < .01$. It may be possible that these language background questionnaire variables uniquely predict language switching patterns beyond proficiency and as such will be included and tested for multicollinearity.

3.2.3. Procedures

Participants signed up for this study by completing a Google Form survey. The link to the Google Form survey was shared widely online on various websites and on flyers posted in classrooms and bulletin boards on campuses. After checking the survey responses, instructions in English and a personal link were sent to all eligible Korean-English bilinguals via email. All participants were tested using the Gorilla Experiment Builder (Anwyl-Irvine et al., 2020) where they completed the consent form, background questionnaire, naming task, lexical decision task, English EIT, and English cloze test via Google Chrome web browser in counterbalanced order (see Appendix 5). The consent form, naming task, lexical decision task, and English EIT were hosted on Gorilla. Links to the background questionnaire and English cloze test appeared on the screen for participants in between tasks and directed participants to Qualtrics and JotForm, respectively.

For the naming task specifically, participants' microphones were tested prior to the instructions screen. Participants were asked to read each word on the screen out loud as accurately and quickly as possible once the word appears on the screen. Participants were informed that they would see and name 200 or so words and their utterances would be recorded. Each word was presented for 1500 ms. (or 1.5 seconds), and the recording began as soon as the word was presented and ended after 2000 ms. There was a total of 8 practice trials and 200 actual trials. Participants received $30 in the form of an Amazon or Starbucks gift card upon completion of the entire study.

3.3. Data preparation and analyses

The 8 practice trials at the beginning of every naming task were discarded. All audio files were checked individually and were uploaded to Chronset to obtain speech onset times. When Chronset failed to provide the speech onset times for a word, the speech onset time was manually obtained through Praat. All speech onset times under 500 ms. and over 1000 ms. were visually checked via Praat and adjusted if necessary. For example, Chronset sometimes analyzed the second syllable in the word as the speech onset, or if there were background noises, Chronset used those sounds as the speech onset. In instances where participants started to utter the word and repaired it with the correct syllable/word, the first utterance of the word/syllable was used for speech onset time. If the word was read incorrectly and the participant was able to correct themselves, then the speech onset time was adjusted to when the word was said correctly.

English pronunciation was for the most part overlooked unless the word uttered sounded more like a different English word. If “author”, for example, was read and pronounced more like “alert”, it was coded as incorrect. If a word was read as three syllables instead of two syllables, it was coded as incorrect. For Korean romanization, any incorrect splitting of syllables was coded as incorrect. For example, if participants read “seongeo” as “seong-eo” instead of “seon-geo”, it was coded as incorrect. Also, if participants misread the Korean romanization, those were coded as incorrect as well.

For the *Hangeul* naming task, after removing the practice trials, less than 1% of the data were incorrect and discarded. For the Korean romanization naming task, after removing the practice trials, 5.65% of the data were incorrect and discarded of which the majority were Korean language trials.

3.4. Results

Linear mixed-effects modeling was used to examine the effects of Language (L1 Korean and L2 English) and Switch (nonswitch and switch trials) on word naming. This type of model accounts for the variability within and across participants and items while also handling missing data (Barr, 2013; Brown, 2021). The dependent variable of reaction time in the mixed effects model was log transformed to conform to a normal distribution. The results of the naming task in *Hangeul* will be presented first in section 3.5.1 followed by the naming task in Korean romanization in section 3.5.2.

3.4.1. Language switching in production (*Hangeul*)

In terms of naming task accuracy, accuracy rates for the 49 participants in the *Hangeul* group were extremely high ranging from 99% to 100% with a mean of 99.76% across all 49 participants. The mean reaction times (RTs) and error rates for the four conditions are below in Table 7. Error rates were low across all conditions ranging from 0.12% to 0.33% suggesting high accuracy on this task overall. Looking at the L1 Korean, switching from L2 English to L1 Korean took longer (636 ms.) than the L1 Korean to L1 Korean trials (600 ms.) on average, which is expected since switching between languages is more cognitively demanding than repeating the same language across trials. Interestingly, however, the L1 Korean to L2 English switch trials were slightly faster (676 ms.) than nonswitch trials from L2 English to L2 English (686 ms.) This means that switching into the L2 English from L1 Korean was not as difficult as remaining in L2 English for this group of participants.

Table 7. Mean RTs by condition in the Hangeul naming task.

	Nonswitch	Error rate	Switch	Error rate	Switching cost
L1 Korean	600 ms. (*SD* = 138)	0.12%	636 ms. (*SD* = 140)	0.29%	+36 ms.
L2 English	686 ms. (*SD* = 150)	0.33%	676 ms. (*SD* = 142)	0.29%	-10 ms.

To investigate the RT data for the *Hangeul*-English naming task and the asymmetric switching pattern from the raw RT further, various mixed effects models with different random effects structures were run. The various models' Akaike information criterion (AIC) and the Bayesian information criterion (BIC) can be found in Table 8 below. The model with a three-way interaction of Language, Switch, and Proficiency (mean-centered EIT scores) with random slopes for language by participant and random intercepts for item had the smallest AIC value. Multiple likelihood ratio tests were run with the maximal model, and the maximal model with AIC of -8144.9 was statistically significant against all other models suggesting that adding the random slope, proficiency, and the interactions with proficiency improved the model fit.

Table 8. AIC and BIC of the various linear mixed-effects models for Hangeul production RT data.

Models	AIC	BIC
Language x switch with random intercepts for participant and item **LogRT ~ Language*Switch + (1|Participant) + (1|Item)**	-7962.8	-7912.6
Language x switch with random slopes for language by participant and random intercepts for item **LogRT ~ Language*Switch + (1+Language|Participant) + (1|Item)**	-8139.6	-8075.1
Language x switch with random slopes for language by participant and random intercepts for item and a proficiency covariate **LogRT ~ Language*Switch+Proficiency + (1+Language|Participant) + (1|Item)**	-8139.2	-8067.5
Language x switch x proficiency with random slopes for language by participant and random intercepts for item **LogRT ~ Language*Switch*Proficiency + (1+Language|Participant) + (1|Item)**	-8144.9	-8051.7

The results of the maximal model can be found in Table 9. In terms of main effects, significant main effects of Language and Switch were observed. Overall, reaction times were slower for English (0.5) compared to Korean (-0.5), $\beta = 0.133$, $t = 12.95$, $p < .001$. In addition, reaction times were slower for switch trials (0.5) compared to repetition trials as a whole (-0.5), . $\beta = 0.057$, $t = 12.85$, $p < .001$. While proficiency alone (EIT mean-centered scores) was not significant ($\beta = -0.001$, $t = -0.42$, $p > .05$), its interactions with Language, Switch, and Language x Switch were either marginally or statistically significant which indicates that L2 proficiency in English is involved in language switching in production for L1 Korean differently than in L2 English. The significant interaction between Language and Switch suggests that switching is asymmetrical with different switching costs for English compared to Korean, $\beta = -0.070$, $t = -11.15$, $p < .001$. The Language and Proficiency interaction term ($\beta = -0.002$, $t = -3.22$, $p < .010$) was also significant which suggests that L2 English language proficiency affects RTs differently for participants in their L1 Korean compared to their L2 English.

Adding length of residence ($\chi^2(1) = 1.10$, $p > .05$) or age of acquisition ($\chi^2(1) = 0.02$, $p > .05$) to the three-way interaction model (Language*Switch*Proficiency) did not improve model fit for the *Hangeul* Korean group in production. Also, the best-fitting three-way interaction model that included EIT as the proficiency variable fit better (AIC = -8144.9, BIC = -8051.7) than the model that used self-reported English proficiency (AIC = -8141.6, BIC = -8048.4) suggesting that objective measure of proficiency (EIT) was a stronger predictor for RTs in the production task for the *Hangeul* group.

Table 9. Mixed effect model estimates for Hangeul production RT data.

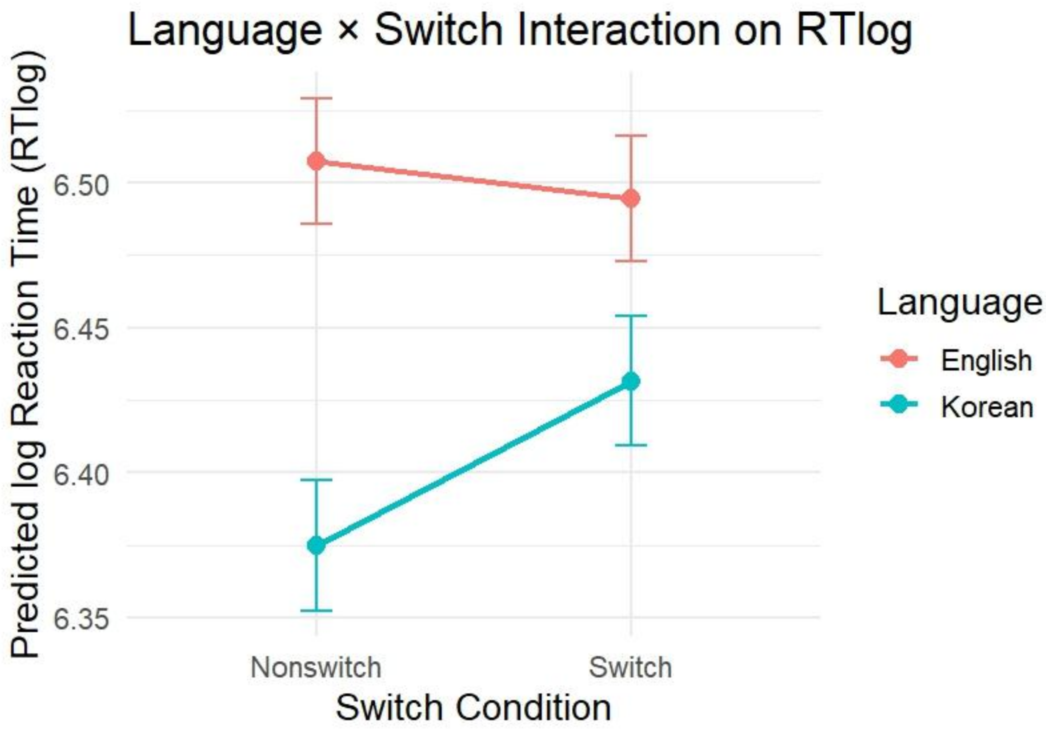
	Estimate	*t* value
Intercept	6.375	284.161***
Language	0.133	12.948***
Switch	0.057	12.853***
Proficiency (mean-centered)	-0.001	-0.415
Language x switch	-0.070	-11.146***
Language x proficiency	-0.002	-3.216**
Switch x proficiency	-0.001	-1.849 .
Language x switch x proficiency	0.001	2.354 *
Random effects	Variance	*SD*
Participant (Intercept)	0.023	0.151
Participant-language	0.002	0.049
Item (Intercept)	0.002	0.042
Residual	0.024	0.153

Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, . = $p < .10$

Figure 1 displays the statistically significant Language and Switch interaction from the mixed effects model described in Table 9. Pairwise comparisons of switch and nonswitch trials by language were run using the R package *emmeans* (Lenth 2025). For the *Hangeul* Korean trials of the naming task, switch trials were slower for the participants compared to nonswitch trials (β = -0.06, SE = 0.004, z = –12.85, $p < .001$). For the English trials of the naming task, switch trials were faster than the nonswitch trials (β = 0.01, SE = 0.004, z = 2.91, $p < .01$). The RTs are higher overall for L2 English compared to L1 Korean, and there is a clear, significant switch cost for L1 Korean that is not seen in the L2 English. These pairwise comparisons are in line with the asymmetrical switching costs observed in previous production studies where switching from the

L2 to the L1 is more taxing than switching from the L1 to L2 due to effortful inhibition of the L1.

Figure 1. Language and Switch interaction on Log RT in Hangeul naming task.



To check the reliability of the 200 item *Hangeul* naming task, a split-half correlation was run between the raw RTs of the even and odd items by participant. Hui and Wu (2023) report that this raw reaction time approach for reliability may be appropriate for studies with a large number of items. A statistically significant correlation between the reaction times on the even and odd items was found, $r(47) = 0.98$, $p < .001$. This suggests that the *Hangeul* naming task that was created had high internal consistency and a reliable measure of language switching in production.

3.4.2. Language switching in production (Korean romanization)

This section will cover the results from the naming task for the Korean romanization group. In terms of accuracy, accuracy rates for the 26 participants in the Korean romanization group were high ranging from 84%[3] to 99% with a mean of 94.35% across all 26 participants. The mean reaction times (RTs) and error rates for the four conditions are below in Table 10. The switching costs observed are different than the *Hangeul* group, such that switching from L2 English to L1 Korean was faster (901 ms.) on average than the L1 Korean-L1 Korean trials (947 ms.) Meanwhile the L1 Korean to L2 English switch trials took longer (791 ms.) compared to the L2 English-L2 English trials (698 ms.) This switching cost of 93 ms. in the L2 direction was not observed in the *Hangeul* naming task. Looking at the error rates, the English error rates are similar to what was observed in the *Hangeul* naming task, but here the error rates for Korean were substantially higher at 11.77% for trials where participants switched from L2 English into L1 Korean and 10.46% for trials where participants remained in L1 Korean.

Table 10. Mean RTs by condition in the Korean romanization naming task.

	Nonswitch	Error rate	Switch	Error rate	Switching cost
L1 Korean	947 ms. (*SD* = 270)	10.46%	901 ms. (*SD* = 245)	11.77%	-46 ms.
L2 English	698 ms. (*SD* = 142)	0.08%	791 ms. (*SD* = 194)	0.31%	+93 ms.

To investigate further into the RT data from the Korean romanization-English naming task, various mixed effects models with different random effects structures were run and their Akaike information criterion (AIC) and the Bayesian information criterion (BIC) were compared. The mixed effects model with the interaction of Language and Switch with random slopes for language by participant and random intercepts for item (LogRT ~ Language*Switch +

[3] Although the cut off was 70% for both production and comprehension tasks in the Korean romanization condition, participants did better on the production task with a minimum of 84% accuracy on the naming task.

(1+Language|Participant) + (1|Item)) was the best fitting model based on AIC and BIC values as well as likelihood ratio test results. Adding length of residence (in months) or age of acquisition did not improve model fit for the Korean romanization group in production. Also, the model with EIT as the proficiency covariate fit better than self-reported English proficiency.

The results of the best-fitting model can be found in Table 11. Significant main effects of Language (β = -0.301, t = -12.88, $p < .001$) and Switch (β = -0.047, t = -6.51, $p < .001$) were observed, which suggests that reaction times were faster for English (0.5) compared to Korean (-0.5) and on switch trials (0.5) compared to repetition trials (-0.5). Note that the direction of these main effects is opposite from what was observed in Table 9 for the *Hangeul* group. The Language and Switch interaction term in this model is significant (β = 0.166, t = 16.94, $p < .001$) suggesting asymmetrical switching costs albeit in the opposite direction from the *Hangeul* group.

Table 11. Mixed effect model estimates for Korean romanization production RT data.

	Estimate	*t* value
Intercept	6.829	199.92***
Language	-0.301	-12.88***
Switch	-0.047	-6.51***
Language x switch	0.166	16.94***
Random effects	Variance	*SD*
Participant (Intercept)	0.028	0.166
Participant-language	0.009	0.094
Item (Intercept)	0.008	0.089
Residual	0.029	0.170

Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, . = $p < .10$

When proficiency is added to the best-fitting model as a covariate (see Table 12), it is a marginally significant predictor of reaction time (β = -0.004, t = -1.79 $p < .10$), which suggests that participants with higher proficiency were faster overall in RT. For every increase in Elicited

Imitation proficiency score from the mean (proficiency was mean-centered in this model), the faster participants performed on the naming task by a 0.004 decrease in log transformed RT.

The addition of proficiency as a covariate to the best-fitting model was only marginally significant better according to a likelihood ratio test, $\chi^2(1) = 3.22$, $p = .07$). However, the model with proficiency as a covariate had a lower AIC value (-2889.8) suggesting that proficiency may be involved in the RT differences among the Korean romanization group.

Table 12. Mixed effect model estimates for Korean romanization group with proficiency covariate.

	Estimate	*t* value
Intercept	6.828	205.60***
Language	-0.301	-12.88***
Switch	-0.047	-6.51***
Proficiency (mean-centered)	-0.004	-1.79 .
Language x switch	0.166	16.94***
Random effects	Variance	*SD*
Participant (Intercept)	0.026	0.161
Participant-language	0.009	0.094
Item (Intercept)	0.008	0.089
Residual	0.029	0.170

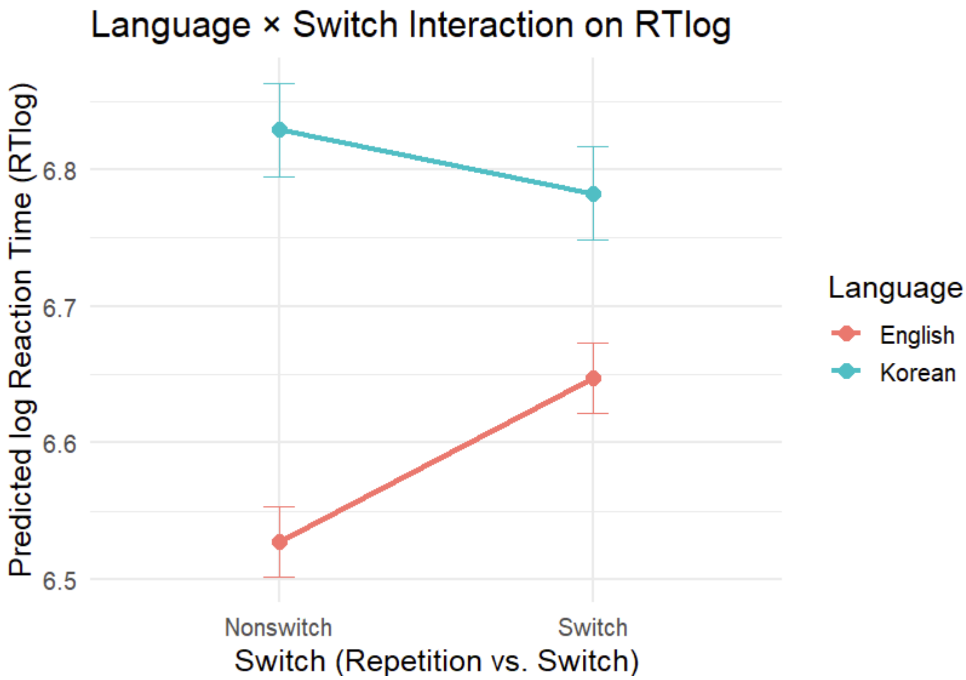
Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, . = $p < .10$

The role of proficiency in the Korean romanization naming task is less profound as the one seen in the *Hangeul* naming task where proficiency significantly interacted with language and switch in a three-way interaction. Adding length of residence ($\chi^2(1) = 0.42$, $p > .05$) or age of acquisition ($\chi^2(1) = 1.02$, $p > .05$) to the marginally best-fitting model with the proficiency covariate did not improve model fit for the Korean romanization group in production. Also, the model with EIT as the proficiency covariate fit better (AIC = -2889.8 BIC = -2824.8) than self-reported English proficiency (AIC = -2886.6, BIC = -2821.7). Appendix 8 provides the mixed effect model estimates for the model that includes the three-way interaction and the interaction of Language by Proficiency. The key difference between the *Hangeul* and Korean romanization production tasks is that the Language by Proficiency was significant for the *Hangeul* naming task, but not for the Korean romanization naming task.

Also, the pattern is reversed such that switching from L1 Korean to L2 English takes longer in the Korean romanization task but switching from the L1 to L2 is faster in the *Hangeul* naming task. In other words, there is an L1 switching cost for *Hangeul* not observed in the Korean romanization task. In addition, there is an L2 switching cost for Korean romanization which was not seen in the *Hangeul* task. So far, this suggests that language switching may be affected by the presentation of Korean. In the first experiment with *Hangeul*, there is no ambiguity on which language to use to name the word. However, for the second experiment with Korean romanization, participants need to process the bivalent stimuli, which led to higher RTs in participants' L1 Korean and an L2 switching cost. In addition to the bivalent nature of English and Korean romanization, Korean romanization may be less familiar among L1 Korean L2 English bilinguals, which may be another reason for the reversed pattern in the Korean romanization version of the naming task.

Figure 2 displays the Language and Switch interaction for the Korean romanization task, and the pattern looks exactly like the *Hangeul* naming task results except there is now a switch benefit in L1 Korean (the blue line that represents Korean items is now on top of the red line that represents English items) and a switch cost from L1 Korean to L2 English. Pairwise comparisons of the switch and nonswitch trials by language were run using the *emmeans* package in R (Lenth 2025). For the Korean romanization trials of the naming task, participants were faster on the switch trials compared to the nonswitch trials ($\beta = 0.047$, $SE = 0.007$, $z = 6.51$, $p < .001$). For the English trials of the naming task, switch trials were slower than the nonswitch trials ($\beta = –0.120$, $SE = 0.007$, $z = –17.84$, $p < .001$).

Figure 2. Language and Switch interaction on Log RT in Korean romanization task.



To check the reliability of the 200 item Korean romanization naming task, a split-half correlation was run between the raw RTs of the even and odd items by participant. A statistically significant correlation between the reaction times on the even and odd items was found, $r(24) = 0.88$, $p < .001$. This suggests that the Korean romanization naming task that was created had high internal consistency and a reliable measure of language switching in production.

3.5. Section discussion

At first glance, Figures 1 and 2 in this section appear similar such that there is a switch benefit for one of the languages and a switch cost for the other language showing asymmetrical switching patterns for production. However, upon closer inspection, the differences in naming task results between the *Hangeul* Korean group and the Korean romanization group are stark. For the *Hangeul* naming task, an L1 switching cost was observed, but for the Korean romanization version of the same task, an L2 switching cost was observed. In the *Hangeul* naming task, participants were faster in their L1 Korean and experienced switching costs from the L2 English to L1 Korean direction. These pattern of results for the *Hangeul* naming task are in line with previous findings that also observed an L1 switching cost for production even in studies where different paradigms were utilized (e.g., picture naming). On the other hand, participants assigned to the Korean romanization task were faster on their L2 English trials overall and experienced switching costs from the L1 Korean to L2 English direction. The only difference between the two tasks was how Korean was presented (either in *Hangeul* or Korean romanization). Thus, while the Language and Switch interaction was significant for both groups suggesting asymmetrical switching for naming, the direction of the switching cost differed depending on orthography.

A possible explanation for the differences between the *Hangeul* and Korean romanization task results may be the script and how easily Korean-English bilinguals can access Korean when *Hangeul* is presented. There may be less coactivation and competition of both languages as soon as *Hangeul* appears on the screen. As predicted, the magnitude of the asymmetrical switching cost was greater in the Korean romanization group compared to the *Hangeul* group most likely due to the shared script. Greater cognitive effort was needed to read words from different languages presented in the same Latin/Roman script. Another possibility is that Korean romanization was simply too difficult for participants to read on the screen. Going back to Table 10 where the mean RTs are presented by condition in the Korean romanization naming task, we see that L1 Korean romanization trials took 249 ms. on average longer than the L2 English trials in the nonswitch condition. Also, error rates were substantially higher for the L1 Korean romanization trials compared to the L2 English trials.

Regarding proficiency, proficiency significantly interacted with other variables for the *Hangeul* naming task, but the addition of proficiency as a covariate was only moderately significant for the Korean romanization naming task. Also, the minimal model without proficiency was actually a better fit for the Korean romanization naming data. Regardless of the orthography, proficiency as measured by EIT was a stronger predictor than the self-reported proficiency that were in the participants' language background questionnaire for these naming tasks.

One potential issue for the production studies is that there were more participants in the Korean romanization group who were unable to complete the naming task at 70% accuracy or higher than those who did. However, a post-hoc power analysis using the R package *mixedpower* (Kumle, Võ, & Draschkow, 2021) suggests that the naming results observed in the Korean romanization group (significant main effects of Language and Switch as well as the significant interaction) would be consistently obtained regardless of the sample size. According to the power analyses output in Table 13, even a smaller sample size of $n = 20$ could detect these effects.

Table 13. Power analysis for the best fitting model for the Korean romanization production data.

	$n = 20$	$n = 30$	$n = 40$	$n = 50$	$n = 60$
Language	1.00	1.00	1.00	1.00	1.00
Switch	1.00	1.00	1.00	1.00	1.00
Language x switch	1.00	1.00	1.00	1.00	1.00

Thus, the differences in sample size between the two groups is not a likely contribution to the patterns observed in production among Korean-English bilinguals. The next chapter covers the results of a language inclusive lexical decision task, where the same participants decided whether English/Korean words presented in *Hangeul* or Korean romanization were words in either language.

Chapter 4: Language Switching in Comprehension

4.1 Study Overview

To examine language switching in comprehension among Korean-bilinguals, a language inclusive lexical decision task was developed. The purpose of this specific lexical decision task was to investigate how Korean-English bilinguals switch between Korean and English and vice versa in comprehension when Korean words were presented in *Hangeul* versus Korean romanization. As outlined in the appendices, participants had to complete an English cloze test in between the naming and lexical decision tasks. Half were assigned to complete the naming task first, and the other half were assigned to complete the lexical decision task first. Participants who completed the naming task in *Hangeul* completed the lexical decision task in *Hangeul*. Likewise, participants who completed the naming task in Korean romanization completed the bilingual lexical decision task in Korean romanization. Only participants who were 70% or higher in accuracy on both their production and comprehension tasks were included in this chapter and the previous chapter.

4.2. Methods

4.2.1. Participants

The same participants described in the previous chapter completed the bilingual lexical decision task. Forty-nine completed the lexical decision task in *Hangeul* and English, and twenty-six completed the lexical decision task in Korean romanization and English. All 75 participants achieved an accuracy rate of 70% or higher on both their production and comprehension tasks. For the comprehension task, the minimum accuracy rate was 70%.

4.2.2. Materials

The same 200 Korean and English words used in the naming task were used for the lexical decision task. For the lexical decision task, an additional 200 nonwords (100 Korean nonwords and 100 English nonwords) were included so that participants could respond affirmatively half of the time during the course of the lexical decision task. The English nonwords were from the English Lexicon Project (Balota, Yap, Cortest, Hutchison, Kessler, Loftis, Neely, Nelson, Simpson, & Treiman, 2007), and the Korean nonwords were adapted from the nonwords used in Kaushanskaya and Yoo (2011).

All items (including nonwords) were assigned to one of four conditions. Four lists were created such that each item (words and nonwords) was presented in every condition across the four counterbalanced lists. The four conditions are below with a brief description:

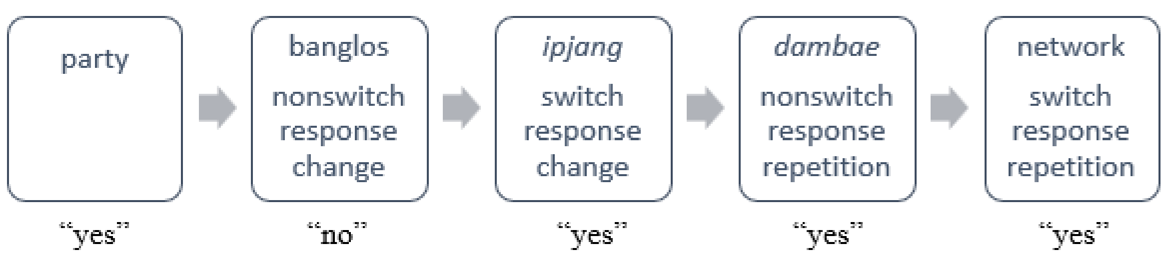
1) Nonswitch response change: Item type changes from word to nonword or nonword to word resulting in a response change (from a positive "yes" to a negative "no", or vice versa), but the language remains the same. An English nonword such as *colob* following an English word such as *office* would be an example of the nonswitch response change condition, where participants would respond "yes" to office then "no" to *colob*.
2) Nonswitch response repetition: Item type repeats itself such that word items follow word items or nonword items follow nonword items resulting in a repeated response (from a positive "yes" to another positive "yes" or a negative "no" to another negative "no"), but the language remains the same. An English word such as *party* following an English word such as *river* would be an example of the nonswitch response repetition condition, where participants would respond "yes" to river then "yes" again to party.

3) Switch response change: Item type changes from word to nonword or nonword to word resulting in a response change (from a positive “yes” to a negative “no”, or vice versa), and the language switches from Korean to English, or vice versa. A Korean word such as *ipjang* (입장) following an English nonword such as *banglos* would be an example of the switch response change condition, where participants would respond “no” to banglos then “yes” to *ipjang* (입장).

4) Switch response repetition: : Item type repeats itself such that word items follow word items or nonword items follow nonword items resulting in a repeated response (from a positive “yes” to another positive “yes” or a negative “no” to another negative “no”), but the language switches from Korean to English, or vice versa. An English word such as *network* following a Korean word such as *dambae* (담배) would be an example of the switch response repetition condition, where participants would respond “yes” to *dambae* (담배) then “yes” again to network.

An example of this type of sequencing of conditions across trials is below:

Figure 3. Example of the sequencing of conditions across trials.



All four lists share the same yes/no response sequence and the same sequencing of conditions. The maximum number of yes and no responses in a row was four. The maximum number of words in a single language in a row was also four. The maximum number of the same condition in a row was two. The languages were alternated in a way that participants would not be able to predict when switching occurs. The lists were designed such that participants will receive the same sequence of language and condition across all four lists, and as a result, will respond affirmatively with a “yes” or negatively with a “no” in the same sequence across all lists.

4.2.3. Procedures

For the lexical decision task specifically, participants were instructed to decide whether each word that appears on the screen exists in Korean or English using “f” for words that do not exist in English or Korean and “j” for words that exist in English or Korean. These two specific keys allow participants to respond with their left and right index fingers. Gorilla Experiment Builder (Anwyl-Irvine et al., 2020) was used for the lexical decision task. Similar to the naming task, target words and nonwords were presented for 1.5 seconds or until a key press response was entered.

4.3. Data preparation and analyses

The 4 practice trials at the beginning of every lexical decision task were discarded. Nonword and incorrect trials were not analyzed. For the *Hangeul* lexical decision task, after removing the practice and nonword trials, 5.01% of the data were incorrect and discarded. From there, less than 1% of correct trials were under 300 ms. which were removed from further analyses. For the Korean romanization lexical decision task, after removing the practice and nonword trials, 12.63% of the data were incorrect and discarded. From there, less than 1% of correct trials were under 300 ms. which were removed from further analyses.

4.4. Results

Linear mixed-effects modeling was used to examine the effects of Language (L1 Korean and L2 English), Switch (nonswitch and switch trials), and Response (repetition and change) on word comprehension. This type of model accounts for the variability within and across participants and items while also handling missing data (Barr 2013; Brown 2021). The dependent variable of reaction time in the mixed effects model was log transformed to conform to a normal distribution. The results of the lexical decision task in *Hangeul* will be presented first in section 4.4.1 followed by the lexical decision task in Korean romanization in section 4.4.2.

4.4.1. Language switching in comprehension (*Hangeul*)

In terms of accuracy, accuracy rates for the 49 participants in the *Hangeul* group were high ranging from 75% to 99% with a mean of 91.57% across all 49 participants. The mean reaction times (RTs), error rates, and switching costs across conditions are in Table 14. Switch costs are observed for L1 Korean overall (35 ms.) and L2 English overall (21 ms.) and also seen in the repetition condition for both Korean (50 ms.) and English (58 ms.) where participants are responding to a word the same way (i.e., two affirmative responses in a row, or two negative responses in a row) they did the trial prior. The most interesting aspect of the raw RT data are the differences in the direction of switch costs in the response change condition for Korean and English.

Table 14. Mean RTs by condition in the Hangeul lexical decision task (n = 49).

	Nonswitch L1-L1	**Error rate**	**Switch L2-L1**	**Error rate**	**Switching cost**
L1 Korean overall	653 ms. (*SD* = 177)	2.95%	688 ms. (*SD* = 201)	3.55%	+35
Korean response repetition	632 ms. (*SD* = 189)	1.89%	682 ms. (*SD* = 195)	3.72%	+50
Korean response change	675 ms. (*SD* = 161)	4.00%	694 ms. (*SD* = 207)	3.31%	+19
	Nonswitch L2-L2	**Error rate**	**Switch L1-L2**	**Error rate**	**Switching cost**
L2 English overall	694 ms. (*SD* =184)	2.84%	715 ms. (*SD* = 190)	3.28%	+21
English response repetition	675 ms. (*SD* = 188)	2.23%	733 ms. (*SD* = 199)	5.30%	+58
English response change	715 ms. (*SD* = 178)	3.46%	697 ms. (*SD* = 179)	1.26%	-18

To investigate further into the RT data for the lexical decision task in *Hangeul* and English, various models with different random effects structures were run and their Akaike information criterion (AIC) and the Bayesian information criterion (BIC) can be found in the table below. The model with a three-way interaction of Language, Switch, and Response type with random slopes for language by participant and random intercepts for item and a proficiency covariate had the smallest AIC and BIC values. Theoretically, adding an interaction of Language and Proficiency could check whether L2 proficiency impacts trials in English vs. Korean. Multiple likelihood ratio tests were run with the model with the smallest AIC and BIC values, and the maximal model with AIC of -2458.4 was statistically significant against all other models suggesting that adding the random slope, adding proficiency as a covariate, the three-way interaction of Language x Switch x Response type, and the Language x Proficiency interaction improved the model fit.

Adding age of acquisition to the best fitting model did not improve model fit for the *Hangeul* Korean group in comprehension, $\chi^2(1) = 0.33$, $p > .05$. Also, the model with EIT as the proficiency covariate fit better (AIC = -2458.4, BIC = -2351.8) than self-reported English proficiency (AIC = -2448.1, BIC = -2341.4). Length of residence ($\chi^2(1) = 6.75$, $p < .01$), however, significantly improved model fit beyond proficiency and is included as part of the appendices. However, the model with the four-way interaction of Language*Switch*Response*Proficiency did not significantly improve model fit compared to the model with Language*Switch*Response + Language*Proficiency, $\chi^2(1) = 10.59$, $p > .10$.

Table 15. AIC and BIC of the linear mixed-effects models for Hangeul comprehension RT data.

Models	AIC	BIC
Language x switch x response type with random intercepts for participant and item **LogRT ~ Language*Switch*Response + (1|Participant) + (1|Item)**	-2293.3	-2214.9
Language x switch x response type with random slopes for language by participant and random intercepts for item **LogRT ~ Language*Switch*Response + (1+Language|Participant) + (1|Item)**	-2360.1	-2267.3
Language x switch with random slopes for language by participant and random intercepts for item with a proficiency covariate **LogRT ~ Language*Switch*Response+Proficiency + (1+Language|Participant) + (1|Item)**	-2453.8	-2354.3
Language x switch with random slopes for language by participant and random intercepts for item with language*proficiency interaction **LogRT ~ Language*Switch*Response+ Language*Proficiency + (1+Language|Participant) + (1|Item)**	-2458.4	-2351.8

The results of the maximal model can be found in Table 16. Significant main effects of Language ($\beta = 0.070$, $t = 5.74$, $p < .001$), Switch ($\beta = 0.080$, $t = 9.304$, $p < .001$), and Response type ($\beta = 0.079$, $t = 9.16$, $p < .001$) were observed, which suggests that reaction times were slower for English (coded as 0.5) compared to Korean (-0.5), slower for switch trials (0.5) compared to nonswitch trials (-0.5), and slower for trials requiring a different, change in response (0.5) compared to the same response (-0.5). The mean-centered Proficiency covariate was not significant, $\beta = -0.002$, $t = -1.15$, $p > .05$. Interestingly, the interaction of Language*Switch was also not significant, $\beta = 0.001$, $t = 0.05$, $p > .05$, which indicates that participants responded to switch trials in a similar pattern for Korean and English (i.e., symmetrical language switching). The interaction of Language*Response type was not significant either , $\beta = -0.017$, $t = -1.39$, $p > .05$, which suggests that participants responded to trials requiring a different response similarly to those that required the same response as the previous trial in Korean and English. The key significant interactions in the model below are the Switch*Response type interaction, $\beta = -0.068$, $t = -5.57$, $p < .001$, suggesting that participants responded to switch and nonswitch trials differently depending on whether the trial required a different response compared to the same response and the Language*Proficiency interaction, $\beta = -0.002$, $t = -2.60$ $p < .05$, suggesting that participants responded to Korean and English trials differently depending on participants' L2 English proficiency. The three-way interaction was significant, $\beta = -0.038$, $t = -2.19$, $p < .05$, which shows that these three variables are working in combination to predict log-transformed RT data in the *Hangeul* comprehension task.

Table 16. Mixed effect model estimates for Hangeul Korean comprehension RT data with proficiency.

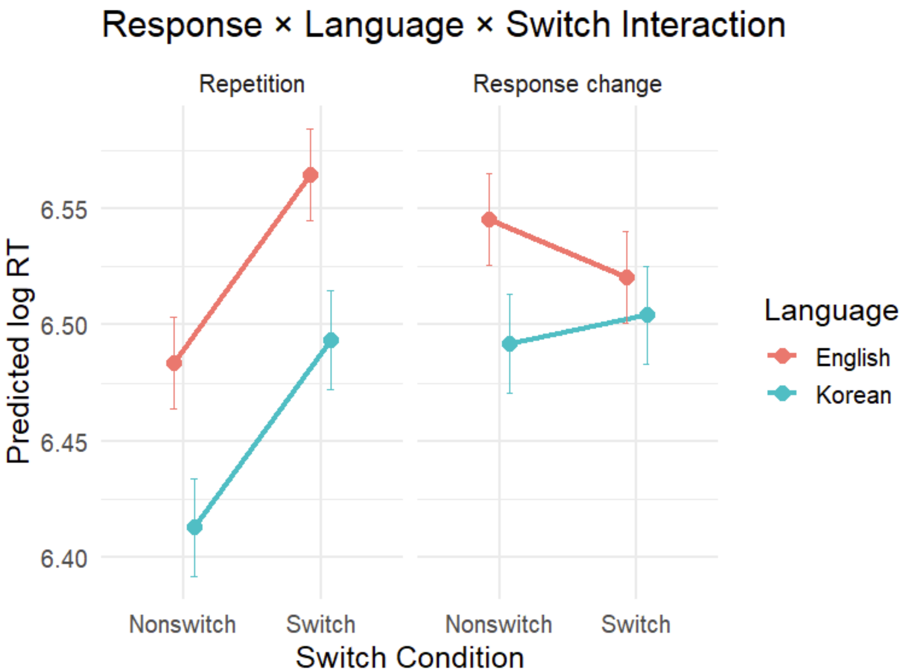
	Estimate	*t* value
Intercept	6.413	306.282***
Language	0.070	5.737***
Switch	0.080	9.304***
Response type	0.079	9.161***
Proficiency	-0.002	-1.145
Language x switch	0.001	0.052
Language x response type	-0.017	-1.390
Switch x response type	-0.068	-5.565***
Language x proficiency	-0.002	-2.601*
Language x switch x response type	-0.038	-2.191*
Random effects	Variance	*SD*
Participant (Intercept)	0.019	0.136
Participant-language	0.002	0.048
Item (Intercept)	0.001	0.037
Residual	0.042	0.206

Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, . = $p < .10$

Figure 4 displays the model in Table 16 where switch costs are symmetrical for English and Korean in the repetition condition (left side of plot). However, there are clear differences on the right side of the plot for the response change condition. English nonswitch response change trials take longer than Korean nonswitch response change trials, but there is a switch benefit for L2 English that is not seen in L1 Korean. In fact, there is a switch cost associated with switching to L1 Korean in the response change trials.

Another interesting aspect of Figure 4 is the difference in slopes between the repetition and response change trials. Switching appears to incur a much larger cost in the repetition trials compared to the response change trials. Overall, Korean was faster overall across all conditions, but switching costs were different between the repetition and response change conditions with an odd switch benefit for English in the response change condition. Pairwise comparisons using *emmeans* (Lenth 2025) was run by language. For L1 *Hangeul* Korean repetition trials, switch trials were slower compared to nonswitch trials (β = –0.080, SE = 0.009, z = –9.30, $p < .001$), but for the L1 *Hangeul* Korean response change trials, there was no difference between the switch and nonswitch trials in RT (β = -0.012, SE = 0.009, z = -1.40, $p > .05$). Looking at the L2 English repetition trials, switch trials were slower compared to nonswitch trials (β = –0.081, SE = 0.009, z = –9.33, $p < .001$), but for the L2 English response change trials, switch trials were faster than the nonswitch trials (β = 0.025, SE = 0.009, z = 2.91, $p < .05$).

Figure 4. Most parsimonious model for Log RT in Hangeul lexical decision task.



To check the reliability of the *Hangeul* lexical decision task, a split-half correlation was run between the raw RTs of the even and odd word items by participant. Hui and Wu (2023) report that this raw reaction time approach for reliability may be appropriate for studies with a large number of items. A statistically significant correlation between the reaction times on the even and odd items was found, $r(47) = 0.96$, $p < .001$. This suggests that the *Hangeul* lexical decision task that was created had high internal consistency and a reliable measure of language switching in comprehension.

4.4.2. Language switching in comprehension (Romanization)

In terms of accuracy, accuracy rates for the 26 participants in the Korean romanization were high ranging from 73% to 91% with a mean of 82.41% across all 26 participants. The mean reaction times (RTs), error rates, and switching costs across conditions are below in Table 17.

Table 17. Mean RTs by condition in the Korean romanization lexical decision task (n = 26).

	Nonswitch L1-L1	**Error rate**	**Switch L2-L1**	**Error rate**	**Switching cost**
L1 Korean overall	973 ms. (SD = 222)	11.51%	946 ms. (SD = 210)	10.71%	-27
Korean response repetition	965 ms. (SD = 226)	10.90%	945 ms. (SD = 217)	9.71%	-19
Korean response change	982 ms. (SD = 217)	11.95%	947 ms. (SD = 202)	11.75%	-35
	Nonswitch L2-L2	**Error rate**	**Switch L1-L2**	**Error rate**	**Switching cost**
L2 English overall	713 ms. (*SD* = 180)	1.84%	773 ms. (SD = 211)	3.55%	+60
English response repetition	689 ms. (*SD* = 182)	1.42%	756 ms. (*SD* = 198)	3.54%	+67
English response change	738 ms. (*SD* = 174)	2.26%	791 ms. (SD = 222)	3.54%	+53

Compared to the *Hangeul* version of the lexical decision task, there are clear differences. The nonswitch trials took longer than the switch trials for Korean, which was not observed in the *Hangeul* version. However, this result is somewhat similar to the Korean romanization naming tasks results where there was an L2 switching cost.

To investigate further into the RD data for the Korean romanization-English lexical decision task, various models with different random effects structures were run and their Akaike information criterion (AIC) and the Bayesian information criterion (BIC) were compared. The model with the interactions of 1) Language and Switch, 2) Language and Response Type, and 3) Switch and Response Type with random slopes for language by participant and random intercepts for item was the best fitting model based on AIC values as well as using likelihood ratio test results. Adding the mean-centered Proficiency covariate did not improve model fit ($\chi^2(1) = 3.61$, $p > .05$) nor did the addition of a Language by Proficiency interaction, $\chi^2(1) = 0.05$, $p > .05$. Adding length of residence ($\chi^2(1) = 2.92$, $p > .05$) or age of acquisition ($\chi^2(1) = 0.11$, $p >$

.05) to the best fitting model did not improve model fit for the Korean romanization group in comprehension.

The results of the best-fitting model can be found in Table 18. Significant main effects of Language (β = -0.348, t = -15.51, p < .001) and Response type (β = 0.027, t = 2.56, p < .05) were observed, which suggests that reaction times were faster for English (0.5) compared to Korean (-0.5) and slower for trials requiring a different, change in response (0.5) compared to the same response (-0.5). Switch alone was not significant for the Korean romanization lexical decision task, β = -0.016, t = -1.50, p > .05.

Interestingly, the interaction of Language*Switch was significant for the Korean romanization group, β = 0.106, t = 8.80, p < .001, which indicates that participants responded to switch trials differently for Korean and English (i.e., asymmetrical language switching). The interaction of Language*Response type was also significant for the Korean romanization group , β = 0.043, t = 3.58, p < .001, which suggests that participants responded to trials requiring a different response differently than those that required the same response as the previous trial for Korean versus English. The significant interactions of Language*Switch and Language*Response type seen here for the Korean romanization group were not statistically significant for the *Hangeul* group. However, similar to what we observed in the *Hangeul* group, Switch*Response type was also significant for the Korean romanization group, β = -0.025, t = -2.05, p < .05, suggesting that participants responded to switch and nonswitch trials differently depending on whether the trial required a different response compared to the same response.

Table 18. Mixed effect model estimates for Korean romanization group.

	Estimate	*t* value
Intercept	6.855	310.830***
Language	-0.348	-15.508***
Switch	-0.016	-1.497
Response type	0.027	2.560*
Language x switch	0.106	8.801***
Language x response type	0.043	3.575***
Switch x response type	-0.024	-2.045*
Random effects	Variance	*SD*
Participant (Intercept)	0.010	0.098
Participant-language	0.008	0.088
Item (Intercept)	0.005	0.071
Residual	0.039	0.198

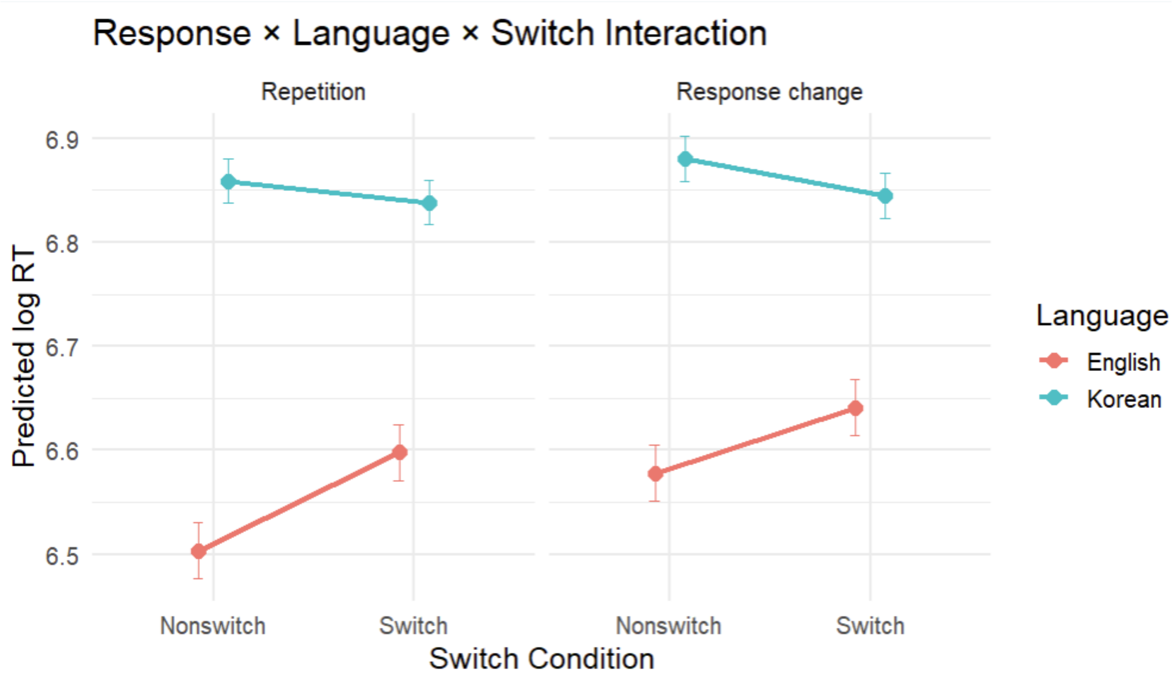
Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, . = $p < .10$

Figure 5 below displays the three-way interaction, which was not significant in the maximal model. The table of the mixed effect model estimates of the three-way interaction can be found in Appendix 9b. Compared to the *Hangeul* Korean group, there are clear differences. For example, the Korean trials overall (blue lines) took longer than the English trials (red lines) for the Korean romanization group. Also, the switching cost from L1 Korean to L2 English seems greater than what was observed for the L2 English to L1 Korean direction. There actually appears to be a switch benefit for switching into L1 Korean, which is confirmed through pairwise comparisons for response change trials specifically.

Pairwise comparisons using *emmeans* (Lenth, 2025) was run by language. For L1 Korean romanization repetition trials, there was no statistically significant difference between the switch and nonswitch trials in RT ($\beta = 0.016$, $SE = 0.011$, $z = 1.50$, $p > .05$), but for the L1 Korean romanization response change trials, there was a significant switch benefit where responses to the switch trials were faster than the nonswitch trials ($\beta = 0.040$, $SE = 0.011$, $z = 3.75$, $p < .01$). Looking at the L2 English repetition trials, there was a significant switching cost where responses to switch trials took longer than the nonswitch trials ($\beta = -0.090$, $SE = 0.010$, $z = -8.91$,

$p < .001$), and for the L2 English response change trials, switch trials again took statistically significantly longer than the nonswitch trials ($\beta = -0.065$, $SE = 0.010$, $z = -6.37$, $p < .001$).

Figure 5. Three-way interaction on Log RT in Korean romanization lexical decision task.



To check the reliability of the Korean romanization lexical decision task, a split-half correlation was run between the raw RTs of the even and odd items by participant. A statistically significant correlation between the reaction times on the even and odd items was found, $r(24) = 0.95$, $p < .001$. This suggests that the Korean romanization lexical decision task that was created had high internal consistency similar to the other tasks in this study and was a reliable measure of language switching in comprehension.

4.5. Section discussion

The differences in lexical decision task results in the *Hangeul* Korean group and the Korean romanization group are clear. In the *Hangeul* lexical decision task, participants were faster in their L1 Korean and experienced symmetrical switching costs from the L2 English to L1 Korean and from their L1 Korean to L2 English. On the other hand, participants assigned to the

Korean romanization task were faster on their L2 English trials overall, and switching costs were asymmetrical for this particular group. The only difference between the two tasks were how Korean was presented (either in *Hangeul* or Korean romanization). For production, the Language and Switch interaction indicating asymmetrical switching costs was significant for both groups regardless of orthography, but for comprehension, the Language and Switch interaction was only significant for the Korean romanization group.

A possible explanation for the differences between the *Hangeul* and Korean romanization task results in comprehension may be again due to the added effort needed to process Korean words presented in Korean romanization. For the Korean romanization group, participants responded to their L1 Korean slower than their L2 English for both the production (naming) task and the comprehension (lexical decision task). Language switching was asymmetrical for the Korean romanization group for both production and comprehension. Meanwhile, language switching was only asymmetrical for the *Hangeul* group in the production task alone. Another possible explanation may be the different processes involved in rejecting a Korean nonword written in *Hangeul* compared to a Korean nonword written in Korean romanization. For Korean nonwords presented in Korean romanization, participants needed to check whether the letter string was a word or not in both languages. However, with *Hangeul*, participants only needed to access Korean lexicon to decide whether the word presented on the screen was a Korean word or not.

Regarding proficiency, proficiency to some degree and length of residence contributed to better model fit for the *Hangeul* comprehension task (see Appendix 9a). The addition of the proficiency covariate to the Korean romanization comprehension model did not improve model fit and was marginally significant within the model when included (see Appendix 9b).

Regardless of the orthography, proficiency as measured by EIT was a stronger predictor than the self-reported proficiency that were reported from the participants' language background questionnaire for these lexical decision tasks.

One potential issue in this study is that there were fewer Korean romanization group participants than *Hangeul* group participants, since more than half of the Korean romanization group were unable to complete the naming task at 70% accuracy or higher. However, a post-hoc power analysis using the R package *mixedpower* (Kumle et al., 2021) suggests that the asymmetrical switching observed in the lexical decision task for the Korean romanization group would be consistently obtained regardless of the sample size. According to the power analyses output in Table 19, even a smaller sample size of n = 20 could detect these effects (please see Language x switch row below).

Table 19. Power analysis for the best fitting model for the Korean romanization LDT task.

	n = 20	n = 30	n = 40	n = 50	n = 60
Language	1.000	1.000	1.000	1.000	1.000
Switch	0.270	0.299	0.383	0.462	0.507
Response	0.570	0.713	0.838	0.898	0.954
Language x switch	1.000	1.000	1.000	1.000	1.000
Language x response	0.883	0.956	0.988	0.999	1.000
Switch x response	0.410	0.505	0.641	0.734	0.788

Thus, the differences in sample size between the two groups is not a likely contribution to the patterns observed in comprehension among Korean-English bilinguals. The next chapter discusses the differences observed between the *Hangeul g*roup and Korean romanization group in regards to their language switching in production and comprehension as well as possible theoretical explanations for these results.

Chapter 5: General Discussion

The present study investigated whether there would be differences in language switching costs in production versus comprehension among Korean-English bilinguals. The study also investigated whether and in what ways L2 English proficiency and orthography affects language switching. This chapter discusses the main findings of the present study along with theoretical implications. Limitations and directions for future research are also discussed at the end of this chapter.

5.1. Research Question 1: Production versus comprehension

There are clear differences in the switch cost patterns between production and comprehension in the present study. For the ease of comparison, only the *Hangeul* group results will be discussed in this section. The Korean romanization group results will be presented in the section 5.3 as part of the language script and orthography discussion. The production task for the *Hangeul* group revealed an L1 switching cost where switching from the L2 English to L1 Korean was more effortful than switching from L1 Korean to L2 English. Meanwhile, for the comprehension task in *Hangeul*, the switching costs appeared to be symmetric (i.e., similar cost to switch in the L2 to L1 direction as well as the L1 to L2 direction). The asymmetrical L1 switching cost for production and the symmetrical switching cost for comprehension observed in the current study has been replicated in previous studies with unbalanced bilinguals (Costa & Santesteban, 2004; Meuter & Allport, 1999; Jackson et al., 2001).

A likely explanation for the different results between the production and comprehension studies for the *Hangeul* group may be related to active rather than passive selection of language in production. For bilinguals, both languages are automatically activated upon the presentation of a word (Bobb & Wodniecka, 2013; Declerck & Philipp, 2015) even across language scripts (Zhang, Wu, & Wang, 2025), but more language control is required for bilinguals to speak in the target language while suppressing the other irrelevant language (Green, 1998). In a comprehension task, such as the language-inclusive decision task utilized in this study, there is no active selection necessary on the part of the bilingual participant for them to decide, for example, whether a word that appears on a screen is a word in one of their languages. According to Green's Inhibitory Control Model (1998), asymmetric switching costs are specifically predicted for production tasks with greater costs switching from the L2 to the L1 due to the persistent, extra suppression required to inhibit the dominant language. An alternative way of explaining the asymmetrical switching cost in production studies was introduced by Philipp et al. (2007), where the authors believe that the over-activation (rather than inhibition) of a language in a trial can persist into the next trial and slow down switching. Teasing apart the inhibition-based account (Green, 1998) and this activation-based account (Philipp et al., 2007) would be difficult to test empirically, since both accounts are not mutually exclusive and both would support an asymmetrical switching cost in L1 for production as seen in the present study.

In addition to the inhibition or activation explanation for asymmetrical language switching costs in production, another account was presented by Verhoef et al. (2009) where they believe that the asymmetry is as a result of fastest reaction times to the L1 repetition condition. In fact, we do see that in the *Hangeul* group that the L1 repetition condition trials were responded to much faster than the other conditions in both the naming task and the lexical decision task. To test their L1 repetition benefit hypothesis, the authors decided to boost picture naming performance in other conditions by introducing short or long periods of time to help participants prepare for the target language in advance. The authors found symmetrical switch costs on long cue-stimulus intervals and asymmetrical switch costs on short cue-stimulus intervals due to faster RTs on the other three conditions in the long cue-stimulus interval condition. The authors confirmed that the only condition that did not show a benefit of preparation was the L1 nonswitch, repeat condition.

However, other studies did not find that preparation modulated language switching. Philipp et al. (2007) observed asymmetrical switch costs regardless of the cue-stimulus interval (100 ms. or 1000 ms.) Also, Mosca and Clahsen (2016) found symmetrical switching costs in their no-preparation trials and an absence of language switching costs in their with-preparation trials. We will discuss this further in the section 5.3 where the L1 nonswitch conditions actually took the longest to respond to in the Korean romanization version of the naming and lexical decision tasks, but this L1 repeat benefit explanation of asymmetrical language switching costs may be less relevant for the current study since no cues or pictures (or preparation time manipulations) were incorporated in the present study.

Looking beyond language control mechanisms and focusing on language processes, speech production requires retrieving the phonological-lexical representation of words while comprehension focuses on the orthographic-lexical and semantic information for a decision-based response (Reynolds, Schlöffel, & Peressotti, 2016). The idea that there are different steps and processing mechanisms for production than comprehension have been echoed by many researchers (Declerck et al., 2013; Declerck & Philipp, 2015; Jiang, 2023; Li & Gollan, 2021; Macizo et al., 2012; Mosca & de Bot, 2017; Peeters et al., 2013) including a recent article by Li et al. (2024) where the authors suggest that endogenous, internal factors such as intending to speak in a certain language is exclusively involved for production but exogenous, external factors such as seeing a word written in a certain language is involved for comprehension. In an earlier article, Li and Gollan (2021) describe the starting points for production and comprehension differently where concepts are activated first for production (in the case of picture naming) and orthography recognized first for comprehension.

Interestingly, the asymmetrical switching costs observed in the current *Hangeul* production task mirrors previous findings including those from cued picture naming task paradigms. Note that this current study is the only one that uniformly investigated production and comprehension language switching costs with the same visual presentation for participants. The fact that a non-cued word-based task (such as the one used in the current study) can elicit the same language switching cost patterns as cued picture naming tasks (Christoffels et al. 2007; Mosca & de Bot, 2017) is novel. Therefore, task type may in fact be less important than the output (e.g., production or comprehension) that the task requires. However, there is limited research on different tasks for production in language switching, and most production studies utilize picture naming. In fact, the link between picture naming and production in language switching studies is so strong that some researchers (Abutalebi & Green, 2008; Li & Gollan, 2021; Reynolds et al., 2016; Schwieter & Sunderman, 2008) default to defining the processes involved in naming an object, such as identifying/conceptualizing the object, accessing the meaning and mapping meaning into a word, and articulating the word to describe language switching in production. It was not expected that the results for this non-cued word-based task would be similar to previous results from picture naming tasks, especially since the word naming task in the current study would guide participants to process the words from bottom-up (e.g., from word recognition) rather than the usual top-down method (e.g., from conceptualization).

Comparing production paradigms, Peeters et al. 2014 and Li and Gollan (2022) also found a similar, asymmetrical L1 switching cost pattern using their unique paradigm where pictures were named in one language within a block of trials and preceded by a printed word from the same language or a different language. In the Peeters et al. (2014) study and Experiment 2 of Li and Gollan (2021), participants were asked to make decisions on the written words while naming pictures. Similar to the present study, both studies avoided artificial, explicit cues such as colors or flags in their pictures and included words and found robust asymmetrical switching costs into the L1 during picture naming in this specific paradigm. An example of another, different production task is the word naming task used in Filippi et al. (2014), which is similar to the current study's production tasks. Despite the use of a different paradigm, the results from the Filippi et al. (2014) also show larger switch costs for the L1 compared to the L2.

Regarding paradigms, there are actually much fewer paradigms used to investigate language switching in production compared to comprehension. Again, picture naming is the most widespread task used to measure language switching in production (Christoffels et al., 2007; Costa & Santesteban, 2004; Schwieter & Sunderman, 2008), but the tasks used for comprehension vary greatly. For example, language switching in comprehension is measured by animacy judgment tasks (de Bruin & Xu, 2023), semantic categorization (Macizo et al., 2012; Struys et al., 2019), and lexical decision tasks (Grainger & Beauvillain, 1987; Orfanidou & Sumner, 2005; Struck & Jiang, 2021; Thomas & Allport, 2000). Even among lexical decision tasks, there are ones where participants need to reject words if they are not the target language (e.g., language exclusive) and others where participants are asked to make lexical decisions using both languages (i.e., language inclusive). While different tasks have been used to measure language comprehension, there is clearly less competition involved in any of the given comprehension tasks. For example, the activation of a Korean word like *chaek* and its translation equivalent "book" will elicit the same semantic categorization, animacy judgment, and lexical decision across languages due to the shared meaning. In fact, the BIA+ does not assume that lexical decision requires any activation or competition (Dijkstra & van Heuven, 2002). Thus, bilinguals may not need to strongly inhibit the nontarget, irrelevant language to comprehend the target, relevant language as they would for a production task. The absence of asymmetrical switching costs in comprehension is often explained as evidence for less competition between languages (Declerck et al., 2019; de Bruin & Xu, 2023).

Regarding comprehension results, the closest study to the current one is Struck and Jiang (2022) where they investigated language switching in comprehension using a language inclusive lexical decision task. Looking at the response repetition trials from the L1 to L2 and vice versa for the *Hangeul* group, the pattern between the current study and Struck and Jiang (2022) is similar and expected, where we see a symmetrical switch cost in the response repetition trials with faster reaction times for the nonswitch compared to the switch trials. However, unlike Struck and Jiang (2022), the current study observed an L1 response change cost and an L2 response change benefit. This means that it took longer to decide that 결과 ("result") was a Korean word or not after an English nonword like "liarp" (liarp -> 결과) compared to 친구 ("friend") after a Korean nonword such as 민빌 (민빌-> 친구). However, it was faster to response to an English word like "treatment" after a Korean nonword like 군휘 (군휘 -> "treatment") than "business" after an English nonword like "trillborn." Nonwords are more challenging to respond to than actual words, and nonwords in a second language may be even more difficult to process. The lexical decision of an L2 word after an L2 nonword may be more difficult than the lexical decision of an L2 word after an L1 nonword. A significant response type x switch interaction was observed for both the *Hangeul* group model and the Korean romanization model in the lexical decision task results.

In the current study, nonwords were excluded as part of the analyses. However, if we go back to the original data and check the average reaction times for all correct English nonwords and all correct Korean nonwords among the *Hangeul* group, there is a statistically significant difference between the two according to a Wilcoxon rank-sum test where Korean-English bilinguals responded more slowly in the English nonword condition (816 ms., SD = 233 ms.) than the Korean nonword condition (707 ms., SD = 191 ms.) Note that a more appropriate paired-sample statistical test (such as a Wilcoxon signed-rank test) could not be run due to missing data from incorrect responses.

Overall, the results from the *Hangeul* production and comprehension tasks are in line with many previous studies such as Macizo et al. 2012, Mosca and de Bot (2017), and Jylkkä et al. (2018a, 2018b), which included both production and comprehension in a single study and provide additional support that language switching in production and comprehension are disparate processes that may be task independent.

5.2. Research Question 2: Role of proficiency

For almost all tasks and groups, proficiency as measured by the English EIT was an important addition in this study as a main effect, covariate, and/or part of an interaction term. No other language switching study other than the current study has utilized EIT as a proficiency measure. If we look at each task individually, we see that for the *Hangeul* naming task (see Table 9), proficiency significantly interacts with language (β = -0.002, t = -3.22, p < .01) and marginally with switch (β = -0.001, t = -1.85, p < .10). Also, the three-way interaction of language, switch, and proficiency is significant as well (β = 0.001, t = 2.35, p < .05). The significant language x proficiency interaction suggests that participants with higher L2 proficiency are faster at naming L2 English words. The marginally significant switch x proficiency interaction suggest that proficient L2 bilinguals experienced reduced switching costs. The three-way interaction of language, switch, and proficiency further suggests that the effect of switching differs across languages depending on L2 proficiency. Specifically, for lower proficiency bilinguals who completed the *Hangeul* naming task, there was a larger switch cost in L1 Korean and smaller switch cost in L2 English. For bilinguals with higher proficiency, there was a smaller switch cost in L1 Korean and larger switch cost in L2 English.

Proficiency appears to play a smaller role in language switching in comprehension compared to production based on the best fitting models. Also, when proficiency was included as a covariate or in interaction terms, significant Language by Proficiency effects were only observed in the *Hangeul* group for both production and comprehension tasks. This indicates that proficiency modulated reaction time differences between L1 Korean and L2 English for the *Hangeul* group only. No significant proficiency interactions were observed in the models for the Korean romanization group. Interestingly, length of residence was only significant as a covariate for the Korean romanization group in comprehension only. In all other models, its addition did not improve model fit.

Previous research has identified that balanced bilinguals whose proficiency in both languages are more equal than disparate may have smaller asymmetrical switching costs (Bonfieni et al., 2019; Costa & Santesteban, 2004; Costa et al., 2006). However, not many studies have included objective measures of proficiency in their study. Among those that did include an objective measure, many measures were similar to the target task (e.g., naming or verbal fluency) and/or were focused on lexical items specifically (e.g., LexTALE). Naming or verbal fluency tasks have been used, because some researchers believe that lexical robustness may play a part in how well bilinguals can switch between their two languages (Schwieter and Sunderman, 2008).

According to the Selection by Proficiency (SbP) model introduced by Schwieter and Sunderman (2008), proficiency as measured by verbal fluency modulates language control such that inhibitory control is necessary for less proficient L2 bilinguals during language switching but not for highly proficient bilinguals. Schwieter and Sunderman (2008) recommended that continuous proficiency measures rather than subjective measures, such as categorical groupings, are used to test the SbP. However, no language switching studies to date have utilized proficiency measures that are readily and widely used in the field of second language studies, such as cloze test or the EIT.

Self-reported language background data is often collected by researchers in language switching research, but when self-reported language proficiency ratings replaced EIT in these analyses, the model fit did not improve according to AIC and BIC values. The objective proficiency measure used in this study (i.e., EIT) was a better fit for the data than the self-reported proficiency ratings provided by the Korean-English bilingual participants for all the analyses.

This study also investigated the role of background variables, such as age of acquisition, and length of residence. Age of acquisition did not improve model fit for any of analyses, and length of residence did not improve model fit for most of the analyses, except for the *Hangeul* comprehension task. Why was it that only length of residence affected the *Hangeul* comprehension task? Could it be that participants' linguistic experiences helped them to comprehend and make decisions about their two languages faster than those who have less experience living in an English-speaking context? Additional variables from the language background questionnaire could be explored further since previous studies have found that switching is modulated by daily L2 exposure (Bonfieni et al., 2019). However, in this study, the actual number of hours spent in one language versus the other was not included in the language background questionnaire, which limits further analyses.

Another factor that cannot be ignored are the between-group differences between the *Hangeul* and Korean romanization groups. Although the initial pool of recruited participants for the *Hangeul* and Korean romanization groups may have been similar in proficiency, the Korean romanization group in particular experienced greater attrition due to poorer performance. Less than half of the Korean romanization group completed both the naming and lexical decision tasks at 70% accuracy or higher. The L2 English proficiency (based on EIT scores) of the Korean romanization group after excluding the participants based on performance was statistically higher than the *Hangeul* group.

Overall, proficiency only seemed to modulate language switching in the *Hangeul* group in production only. The idea that proficiency is important for production but not comprehension has been proposed by Kroll and Stewart's (1994) RHM, which hypothesizes that there is a direct link between words and concepts in the L1. For unbalanced or early bilinguals with low L2 proficiency levels, these bilinguals must activate the L1 word first to produce the L2 word and cannot directly access the concept through the L2. However, balanced bilinguals or those with higher levels of L2 proficiency may be able to produce L2 words without the L1 and directly access concepts via the L2. Going back to the significant interactions observed in the *Hangeul* group in the production task, participants with higher proficiency had smaller switch costs and were faster at naming L2 words, and the significant three-way interaction of Language*Switch*Proficiency, suggests that switching costs by language were modulated by proficiency for the *Hangeul* naming task. These results are in alignment with the RHM where more proficient bilinguals have stronger links from L2 words to concepts and faster lexical access in production.

5.3. Research Question 3: Role of orthography

Across the production and comprehension tasks, as predicted, there was a clear advantage for the *Hangeul* over the Korean romanization version of the tasks. There was a processing advantage for participants assigned to the *Hangeul* group over the Korean romanization group as indicated by speeded reaction times and overall higher accuracy. This advantage may be attributed to the fact that there are language-specific nodes or tags associated with the presentation of *Hangeul* Korean (Green, 1998; Dijkstra & van Heuven, 2002). In other words, *Hangeul* serves as an orthographic cue in a *Hangeul*/English task. According to the BIA+, if two languages differ in terms of orthography, the initial set of lexical candidates may be limited to that language. Korean-English bilinguals can easily access Korean when *Hangeul* is presented, but may need time and effort to process words when presented in the same Latin/Roman script (in the case of Korean romanization and English).

The presentation of Korean romanization among English words clearly made processing words in the naming and lexical decision task more challenging. For the naming task, the mean raw reaction time for the Korean romanization words across switch and nonswitch trials was 924 ms. (*SD* = 259). Meanwhile, the mean raw reaction time for the *Hangeul* Korean words in the naming task across switch and nonswitch trials was 618 ms. (*SD* = 140). For the lexical decision task, the mean raw reaction time for the Korean romanization words across all conditions was 959 ms. (*SD* = 216). For the *Hangeul* group, the mean raw reaction time for Korean words in the lexical decision task across all trials was 670 ms. (*SD* = 190). Thus, it takes about 300 ms. longer on average for those completing the Korean romanization tasks to say or process a word in their L1 Korean compared to the Korean-English bilinguals who completed the tasks in *Hangeul*. The higher error rates and the extra 300 ms. or so of processing time for Korean words presented in romanization for both tasks suggests an effortful, conscious decoding process may be occurring for the Korean romanization tasks. Meanwhile, *Hangeul* may allow for direct lexical access speeded by whole-word or syllabic recognition.

In terms of switching costs, we actually see an L2 switching cost in the Korean romanization naming task suggesting that switching from the L1 Korean to L2 English was more taxing than from L2 English to L1 Korean. In the *Hangeul* version of the same exact naming task, an opposite L1 switching cost was observed where switching from the L2 English to L1 Korean was more effortful. For comprehension, we see the L2 switching cost again in the Korean romanization version of the language inclusive lexical decision task. Meanwhile, in the *Hangeul* version of the same exact lexical decision task, symmetrical switching costs were observed. Looking at the magnitude of the costs in raw reaction time, the costs appear to be smaller with the *Hangeul* group, which is in line with Orfanidou and Sumner (2005) where they found smaller switch costs in Experiment 1 with their language-specific stimuli compared to their language non-specific stimuli.

If we look at the mean raw reaction times, responses to L2 English words were much more stable across tasks as well as between groups and most importantly, responses to L2 English words for the Korean romanization group were faster than their responses to L1 Korean words. For the naming task, the mean raw reaction time for the English words across switch and nonswitch trials was 681 ms. (SD = 146) for the *Hangeul* group and 744 ms. (SD = 177) for the Korean romanization group. For the lexical decision task, the mean raw reaction time for the

English words across all conditions was 705 ms. (*SD* = 187) for the *Hangeul* group and 742 ms. (*SD* = 198) for the Korean romanization group. These raw mean reaction times for L2 English across tasks and groups were more comparable than what was observed for the L1 Korean across tasks and groups.

A few researchers (Finkbeiner et al., 2006; Orfanidou & Sumner, 2004; Slevc et al., 2016) proposed another problem with investigating language specific versus language non-specific orthography. If words are language specific due to orthography, they could be considered more univalent (specific to one language) where words that contain mainly language non-specific orthography could be considered more bivalent (possible in both languages). Task switching literature provides evidence that bivalency results in larger switch costs because more than one response is possible and thus both languages become activated due to the increased language interference (Allport et al., 1994).

Thus, another way to look at the differences between the *Hangeul* Korean group and the Korean romanization group is to consider stimuli type. The *Hangeul* Korean group were exposed to univalent stimuli, while the Korean romanization were exposed to orthographically bivalent stimuli. Green and Abutalebi (2013) argue that there is adaptive control of the bilingual's two languages that reflect environmental demands suggesting that identifying how language processes are impacted by the unique requirements in a given environment is important, which may explain why the L1 Korean took longer than the L2 English for the Korean romanization group. For the romanization version of the tasks, the L2 English became less challenging and the L1 Korean had to be decoded from romanization to *Hangeul* for naming and lexical decision making. However, at the same time, it is difficult to tease apart whether these results are due to the stimuli type or a lack of familiarity or exposure to Korean romanization among participants.

Lastly, while a few studies have reported a reversed language dominance effect (Philipp et al., 2007; Timmer et al., 2019, for example) where naming or responses to L2 is faster than in the L1, this was not observed in the *Hangeul* naming or lexical decision tasks. This reversed language dominance effect only appeared in the Korean romanization naming and lexical decision tasks where the task became bivalent. The reversed language dominance effect is seen in studies where picture naming or digit naming is used, which is exactly where the reversed language dominance effect occurred in the current study (with the bivalent Korean romanization tasks).

5.4. Limitations and future directions

Keeping the task uniform (i.e., displaying Korean and English words on screen for 1.5 seconds) across the production and comprehension task allowed for clearer comparisons, but in many ways, this type of language switching may not be as ecologically valid as switching between languages within a sentence, paragraph, and conversation. Recent studies seem to pivot away from language switching at the word level to focus on language switching within a sentence (Zhu, Sturt, & Damien, 2025), in a paragraph (Li et al., 2024), or in a conversational setting (Han, Li, & Filippi, 2025).

Regarding high participant attrition and poor performance in the Korean romanization group, a training session or additional practice items on Korean romanization would have been beneficial. Looking at the language background questionnaire data on romanization, the range of familiarity with romanization varied greatly across the participants (but not between-groups). Appendix 10 provides the coded responses from the romanization question in the Korean romanization group. The question was open-ended, so the individual responses were categorized into four groups from very familiar with Korean romanization to not familiar with it at all. While

Korean romanization is considered orthographically bivalent with English, the slowdown in the word naming and lexical decision in the Korean romanization group could simply be attributed to less familiarity with identifying words in Korean romanization rather than due to stimulus valency. A way to check this would have been to include a separate Korean lexical decision task with words presented in *Hangeul* and Korean romanization to directly compare differences in response latencies between the two scripts.

Also, while conducting a within-subjects study would have been ideal over the current between-subjects design, logistically, there were some challenges with recruiting Korean-English bilinguals for this study. Most of the participants who signed up were connected to me in some way (e.g., through friends, colleagues, or professional contacts), and after sending the email and link with instructions, I had to regularly follow up with participants regarding their participation.

A possible follow-up to this study specifically to further explore the role of language script would be to test L1 Japanese L2 English bilinguals, since their romanization system is extremely familiar to L1 Japanese native speakers and there has only been one system in place compared to the many Korean romanization systems (e.g., Yale, McCune–Reischauer, etc.) that have been introduced prior to the official use of the Revised Romanization system in 2000. Also, Japanese tends to have a set consonant-vowel (CV) syllable structure, which is less complex than the consonant-vowel-consonant (CVC) or consonant-vowel-consonant-consonant (CVCC) structures in Korean.

Lastly, it would be interesting to test Korean-English bilingual participants who regularly and systematically switch between their two languages, such as heritage language learners. While there is a plethora of studies on qualitative code-switching research in heritage language learners, there is little research on quantitative language switching in this particular group.

Hernandez Santacruz, Torres, and Kroll (2025) explored language mixing in Spanish-English heritage language learners using a blocked language picture naming task. However, this particular study may be the only one on this particular population of learners in the area of language mixing/switching. All others seem to focus on simultaneous bilinguals or sequential bilinguals with the majority of studies, including the current one, on the latter. Hernandez Santacruz et al. (2025) suggest that there may be different language switching patterns for specific learner populations. In the case of heritage speakers who maintain their dominant L2 along with their L1, they may switch more frequently between their two languages especially in certain interactional contexts. At the same time, heritage language learners are monitoring interference and inhibiting irrelevant languages in distinct situations (e.g., Korean at home but English at work and school), and as a result, these bilinguals may have different language control strategies than the current population that was recruited in the current study.

Another interesting research question would be the introduction of LexTALE alongside proficiency measures such the English cloze test or the EIT. Correlations between LexTALE and other objective, widely accepted measures of the English cloze test and the EIT would aid in the understanding of LexTALE, since it is frequently used in these types of language switching studies, especially since LexTALE was originally designed as a measure of vocabulary.

5.5. Conclusion

The present study explored language switching in Korean-English bilinguals and investigated how task demands, proficiency, and orthography contributes to switching costs and patterns between languages. A total of seventy-five Korean-English bilinguals successfully participated in this study and completed a bilingual naming task in either *Hangeul*/English or Korean romanization/English, a language-inclusive lexical decision task (also in

Hangeul/English or Korean romanization/English), a language background questionnaire, and two proficiency measures: an English cloze test and the English Elicited Imitation Task (EIT) of which the latter was included in the analyses.

In the naming task under the *Hangeul*/English condition, switching costs were greater when switching from L2 English to L1 Korean than in the reverse direction. However, in the romanization version of the task, the pattern was reversed: switching from L1 Korean to L2 English incurred greater costs. In the lexical decision task, switching costs were symmetrical for the *Hangeul* group but asymmetrical for the romanization group, with greater costs observed when switching from L1 Korean to L2 English with different costs and benefits depending on the response type. Proficiency, as measured by the EIT, played a significant role in reaction times across most tasks.

Taken together, we can conclude that language switching processes are distinct for production and comprehension in line with previous findings and hypotheses. L2 proficiency appears to modulate language switching in production for the *Hangeul* group while orthography plays a role in language switching patterns, such that shared orthography may be more challenging to process than languages of distinct orthographies. A combination of various models (not a single one) may be needed to explain language switching in bilinguals.

No other study to date has investigated language switching in production and comprehension in a uniformed way for clear comparisons with an objective measure of proficiency unrelated to the main tasks and shared and different orthographic systems to better understand the language switching phenomenon in bilinguals. The results from the *Hangeul* task specifically suggest that the L1 switching cost in production may be task independent since the naming of words resulted in the same pattern of results obtained from cued picture naming and there are differences between production and comprehension when participants are provided with the same visual display (e.g., words on a screen across both production and comprehension).

Appendices

Appendix 1: Stimuli for Production Task (Naming)

	List A ***Hangeul***	**List A Romanization**	**List B** ***Hangeul***	**List B Romanization**	**Condition**
	shelter	shelter	shelter	shelter	practice
	모두	modu	모두	modu	practice
	ceiling	ceiling	ceiling	ceiling	practice
	현상	hyeonsang	현상	hyeonsang	practice
	기억	giyeok	기억	giyeok	practice
	tourist	tourist	tourist	tourist	practice
	usage	usage	usage	usage	practice
	무녀	munyeo	무녀	munyeo	practice
1	method	method	table	table	1=switch
2	order	order	version	version	2=nonswitch
3	career	career	resource	resource	2=nonswitch
4	문학	munhak	단체	danche	1=switch
5	상태	sangtae	마음	maeum	2=nonswitch
6	agent	agent	letter	letter	1=switch
7	system	system	dollar	dollar	2=nonswitch
8	office	office	concern	concern	2=nonswitch
9	경제	gyeongje	생활	saenghwal	1=switch
10	시간	sigan	교수	gyosu	2=nonswitch
11	husband	husband	attack	attack	1=switch
12	network	network	subject	subject	2=nonswitch
13	자신	jasin	시험	siheom	1=switch
14	city	city	season	season	1=switch
15	담배	dambae	사장	sajang	1=switch
16	생각	saenggak	문학	munhak	2=nonswitch
17	data	data	reason	reason	1=switch
18	minute	minute	impact	impact	2=nonswitch
19	amount	amount	husband	husband	2=nonswitch
20	회사	hoesa	발전	baljeon	1=switch
21	마을	maeul	한참	hancham	2=nonswitch
22	police	police	party	party	1=switch
23	과학	gwahak	상태	sangtae	1=switch
24	선거	seongeo	노래	norae	2=nonswitch
25	작업	jageop	결혼	gyeolhon	2=nonswitch
26	river	river	window	window	1=switch
27	환자	hwanja	물건	mulgeon	1=switch
28	발전	baljeon	계획	gyehoek	2=nonswitch
29	summer	summer	product	product	1=switch
30	adult	adult	factor	factor	2=nonswitch
31	window	window	million	million	2=nonswitch

	List A *Hangeul*	List A Romanization	List B *Hangeul*	List B Romanization	Condition
32	얼굴	eolgul	대화	daehwa	1=switch
33	statement	statement	morning	morning	1=switch
34	region	region	record	record	2=nonswitch
35	사실	sasil	가치	gachi	1=switch
36	practice	practice	effect	effect	1=switch
37	action	action	artist	artist	2=nonswitch
38	손님	sonnim	관계	gwangye	1=switch
39	movement	movement	theory	theory	1=switch
40	detail	detail	market	market	2=nonswitch
41	sister	sister	music	music	2=nonswitch
42	한참	hancham	오늘	oneul	1=switch
43	양반	yangban	과학	gwahak	2=nonswitch
44	단체	danche	전체	jeonche	2=nonswitch
45	answer	answer	sister	sister	1=switch
46	table	table	decade	decade	2=nonswitch
47	역할	yeokhal	문제	munje	1=switch
48	내일	naeil	대표	daepyo	2=nonswitch
49	관계	gwangye	학생	haksaeng	2=nonswitch
50	dollar	dollar	model	model	1=switch
51	theory	theory	second	second	2=nonswitch
52	정도	jeongdo	과거	gwageo	1=switch
53	기슬	giseul	환자	hwanja	2=nonswitch
54	version	version	action	action	1=switch
55	effect	effect	father	father	2=nonswitch
56	paper	paper	color	color	2=nonswitch
57	마음	maeum	운동	undong	1=switch
58	woman	woman	language	language	1=switch
59	morning	morning	couple	couple	2=nonswitch
60	머리	meori	신문	sinmun	1=switch
61	과거	gwageo	하루	haru	2=nonswitch
62	연구	yeongu	학교	hakgyo	2=nonswitch
63	artist	artist	story	story	1=switch
64	campaign	campaign	support	support	2=nonswitch
65	question	question	response	response	2=nonswitch
66	순간	sungan	마을	maeul	1=switch
67	member	member	player	player	1=switch
68	daughter	daughter	design	design	2=nonswitch
69	approach	approach	feeling	feeling	2=nonswitch
70	산업	saneop	기슬	giseul	1=switch
71	number	number	network	network	1=switch
72	body	body	parent	parent	2=nonswitch
73	입장	ipjang	생각	saenggak	1=switch
74	중심	jungsim	시대	sidae	2=nonswitch
75	market	market	treatment	treatment	1=switch
76	사회	sahoe	친구	chingu	1=switch

	List A *Hangeul*	List A Romanization	List B *Hangeul*	List B Romanization	Condition
77	친구	chingu	대회	daehoe	2=nonswitch
78	지금	jigeum	자신	jasin	2=nonswitch
79	feeling	feeling	section	section	1=switch
80	program	program	mother	mother	2=nonswitch
81	사진	sajin	세상	sesang	1=switch
82	level	level	report	report	1=switch
83	model	model	data	data	2=nonswitch
84	treatment	treatment	statement	statement	2=nonswitch
85	사랑	sarang	시간	sigan	1=switch
86	나무	namu	정보	jeongbo	2=nonswitch
87	father	father	adult	adult	1=switch
88	노래	norae	선거	seongeo	1=switch
89	현실	hyeonsil	역할	yeokhal	2=nonswitch
90	문제	munje	담배	dambae	2=nonswitch
91	color	color	minute	minute	1=switch
92	계획	gyehoek	하늘	haneul	1=switch
93	국가	gukga	사실	sasil	2=nonswitch
94	resource	resource	approach	approach	1=switch
95	모양	moyang	문화	munhwa	1=switch
96	시민	simin	회사	hoesa	2=nonswitch
97	물건	mulgeon	정도	jeongdo	2=nonswitch
98	building	building	message	message	1=switch
99	player	player	level	level	2=nonswitch
100	학교	hakgyo	연구	yeongu	1=switch
101	사장	sajang	경우	gyeongu	2=nonswitch
102	million	million	order	order	1=switch
103	option	option	building	building	2=nonswitch
104	meeting	meeting	defense	defense	2=nonswitch
105	영화	yeonghwa	양반	yangban	1=switch
106	union	union	business	business	1=switch
107	season	season	series	series	2=nonswitch
108	소설	soseol	관심	gwansim	1=switch
109	event	event	daughter	daughter	1=switch
110	정보	jeongbo	지금	jigeum	1=switch
111	문화	munhwa	자연	jayeon	2=nonswitch
112	하늘	haneul	상황	sanghwang	2=nonswitch
113	decade	decade	body	body	1=switch
114	내용	naeyong	가정	gajeong	1=switch
115	power	power	percent	percent	1=switch
116	letter	letter	author	author	2=nonswitch
117	people	people	success	success	2=nonswitch
118	사건	sageon	내일	naeil	1=switch
119	모습	moseup	지방	jibang	2=nonswitch

	List A *Hangeul*	List A Romanization	List B *Hangeul*	List B Romanization	Condition
120	series	series	detail	detail	1=switch
121	future	future	union	union	2=nonswitch
122	시대	sidae	그림	geurim	1=switch
123	운동	undong	손님	sonnim	2=nonswitch
124	말씀	malsseum	교육	gyoyuk	2=nonswitch
125	mother	mother	region	region	1=switch
126	report	report	method	method	2=nonswitch
127	정신	jeongsin	정치	jeongchi	1=switch
128	대학	daehak	소리	sori	2=nonswitch
129	design	design	money	money	1=switch
130	section	section	answer	answer	2=nonswitch
131	message	message	image	image	2=nonswitch
132	학생	haksaeng	필요	pilyo	1=switch
133	오늘	oneul	영화	yeonghwa	2=nonswitch
134	subject	subject	people	people	1=switch
135	소리	sori	대학	daehak	1=switch
136	전화	jeonhwa	내용	naeyong	2=nonswitch
137	세상	sesang	경제	gyeongje	2=nonswitch
138	author	author	question	question	1=switch
139	product	product	power	power	2=nonswitch
140	상황	sanghwang	저녁	jeonyeok	1=switch
141	저녁	jeonyeok	사랑	sarang	2=nonswitch
142	관심	gwansim	집단	jipdan	2=nonswitch
143	second	second	doctor	doctor	1=switch
144	표정	pyojeong	바람	baram	1=switch
145	시험	siheom	입장	ipjang	2=nonswitch
146	couple	couple	option	option	1=switch
147	water	water	city	city	2=nonswitch
148	지방	jibang	말씀	malsseum	1=switch
149	기능	gineung	눈물	nunmul	2=nonswitch
150	impact	impact	office	office	1=switch
151	project	project	number	number	2=nonswitch
152	attack	attack	agent	agent	2=nonswitch
153	교육	gyoyuk	아들	adeul	1=switch
154	가치	gachi	순간	sungan	2=nonswitch
155	음식	eumsik	정신	jeongsin	2=nonswitch
156	concern	concern	career	career	1=switch
157	집단	jipdan	전화	jeonhwa	1=switch
158	아들	adeul	고향	gohyang	2=nonswitch
159	service	service	project	project	1=switch
160	disease	disease	member	member	2=nonswitch
161	결혼	gyeolhon	기능	gineung	1=switch
162	필요	pilyo	얼굴	eolgul	2=nonswitch

	List A *Hangeul*	List A Romanization	List B *Hangeul*	List B Romanization	Condition
163	역사	yeoksa	사건	sageon	2=nonswitch
164	support	support	paper	paper	1=switch
165	doctor	doctor	woman	woman	2=nonswitch
166	business	business	practice	practice	2=nonswitch
167	하루	haru	나무	namu	1=switch
168	그림	geurim	노력	noryeok	2=nonswitch
169	factor	factor	disease	disease	1=switch
170	대표	daepyo	음식	eumsik	1=switch
171	생활	saenghwal	사회	sahoe	2=nonswitch
172	record	record	amount	amount	1=switch
173	study	study	event	event	2=nonswitch
174	reason	reason	summer	summer	2=nonswitch
175	노력	noryeok	모습	moseup	1=switch
176	가정	gajeong	소설	soseol	2=nonswitch
177	신문	sinmun	표정	pyojeong	2=nonswitch
178	image	image	study	study	1=switch
179	눈물	nunmul	현실	hyeonsil	1=switch
180	정치	jeongchi	사진	sajin	2=nonswitch
181	defense	defense	campaign	campaign	1=switch
182	money	money	river	river	2=nonswitch
183	대회	daehoe	중심	jungsim	1=switch
184	music	music	program	program	1=switch
185	고향	gohyang	국가	gukga	1=switch
186	결과	gyeolgwa	모양	moyang	2=nonswitch
187	대화	daehwa	산업	saneop	2=nonswitch
188	success	success	water	water	1=switch
189	전체	jeonche	결과	gyeolgwa	1=switch
190	바람	baram	머리	meori	2=nonswitch
191	comment	comment	system	system	1=switch
192	party	party	comment	comment	2=nonswitch
193	경우	gyeongu	작업	jageop	1=switch
194	parent	parent	future	future	1=switch
195	percent	percent	police	police	2=nonswitch
196	story	story	movement	movement	2=nonswitch
197	자연	jayeon	역사	yeoksa	1=switch
198	response	response	meeting	meeting	1=switch
199	language	language	service	service	2=nonswitch
200	교수	gyosu	시민	simin	1=switch

Appendix 2: Stimuli for Comprehension Task (Lexical Decision Task)

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
	usage	usage	usage	usage	usage	usage	usage	usage	w	N/A
	felping	felping	felping	felping	felping	felping	felping	felping	n	N/A
	무녀	munyeo	무녀	munyeo	무녀	munyeo	무녀	munyeo	w	N/A
	쿠마	kuma	쿠마	kuma	쿠마	kuma	쿠마	kuma	n	N/A
1	liarp	liarp	colob	colob	beaty	beaty	banglos	banglos	n	3 = switch, repetition
2	결과	gyeolgwa	경우	gyeongu	말씀	malsseum	입장	ipjang	w	4 = switch, response change
3	대회	daehoe	음식	eumsik	사회	sahoe	마을	maeul	w	1= nonswitch, repetition
4	efter	efter	sarnish	sarnish	lanceg	lanceg	feasants	feasants	n	4 = switch, response change
5	oltet	oltet	wooxen	wooxen	manper	manper	pagnum	pagnum	n	1= nonswitch, repetition
6	기슬	giseul	사진	sajin	전화	jeonhwa	시대	sidae	w	4 = switch, response change
7	과학	gwahak	시민	simin	소설	soseol	대화	daehwa	w	1= nonswitch, repetition
8	trillborn	trillborn	manper	manper	colob	colob	favel	favel	n	4 = switch, response change
9	business	business	number	number	player	player	design	design	w	2 = nonswitch, response change
10	welleg	welleg	umbound	umbound	eggthell	eggthell	reltas	reltas	n	2 = nonswitch, response change
11	중심	jungsim	소설	soseol	양반	yangban	학생	haksaeng	w	4 = switch, response change
12	꾸거	kkugeo	휘조	hwijo	턱똔	teoktton	거쪄	geojjeo	n	2 = nonswitch, response change
13	necline	necline	daping	daping	yellep	yellep	feports	feports	n	3 = switch, repetition
14	민빌	minbil	꾸거	kkugeo	테힐	tehil	삿모	satmo	n	3 = switch, repetition
15	친구	chingu	영화	yeonghwa	국가	gukga	경우	gyeongu	w	2 = nonswitch, response change
16	scoved	scoved	ildent	ildent	krockout	krockout	nello	nello	n	4 = switch, response change
17	잔린	janrin	헨밸	henbael	린갑	ringap	거뒹	geodwing	n	3 = switch, repetition
18	처포	cheopo	턱똔	teoktton	투회	tuhoe	테키	teki	n	1= nonswitch, repetition
19	project	project	decade	decade	order	order	method	method	w	4 = switch, response change
20	success	success	attack	attack	couple	couple	body	body	w	1= nonswitch, repetition

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
21	halrus	halrus	ticeps	ticeps	tandits	tandits	harnings	harnings	n	2 = nonswitch, response change
22	system	system	success	success	water	water	parent	parent	w	2 = nonswitch, response change
23	노력	noryeok	연구	yeongu	사랑	sarang	아들	adeul	w	3 = switch, repetition
24	tandits	tandits	banper	banper	ceelings	ceelings	ticeps	ticeps	n	4 = switch, response change
25	디마	dima	베쪄	bejjeo	빌균	bilgyun	쩌럭	jjeoreok	n	3 = switch, repetition
26	briskel	briskel	duno	duno	chorax	chorax	kervish	kervish	n	3 = switch, repetition
27	모습	moseup	사회	sahoe	단체	danche	담배	dambae	w	4 = switch, response change
28	image	image	reason	reason	number	number	network	network	w	3 = switch, repetition
29	따빌	ttabil	트모	teumo	균밉	gyunmip	떠눌	tteonul	n	4 = switch, response change
30	군휘	gunhwi	센벽	senbyeok	힐모	hilmo	힐빔	hilbim	n	1= nonswitch, repetition
31	treatment	treatment	impact	impact	morning	morning	subject	subject	w	4 = switch, response change
32	ainport	ainport	estras	estras	winber	winber	dumid	dumid	n	2 = nonswitch, response change
33	money	money	building	building	attack	attack	defense	defense	w	2 = nonswitch, response change
34	response	response	percent	percent	factor	factor	product	product	w	1= nonswitch, repetition
35	겔밉	gelmip	둔거	dungeo	미턱	miteok	둑삐	dukppi	n	4 = switch, response change
36	생각	saenggak	소리	sori	필요	pilyo	얼굴	eolgul	w	2 = nonswitch, response change
37	역할	yeokhal	모습	moseup	경제	gyeongje	전화	jeonhwa	w	1= nonswitch, repetition
38	union	union	business	business	woman	woman	player	player	w	3 = switch, repetition
39	record	record	treatment	treatment	author	author	season	season	w	1= nonswitch, repetition
40	꺼루	kkeoru	미쥬	mijyu	테키	teki	테힐	tehil	n	4 = switch, response change
41	agrials	agrials	dathers	dathers	hanget	hanget	sazer	sazer	n	3 = switch, repetition
42	둔거	dungeo	테키	teki	처쥬	cheojyu	끄헨	kkeuhen	n	3 = switch, repetition
43	그림	geurim	입장	ipjang	관계	gwangye	집단	jipdan	w	2 = nonswitch, response change
44	banglos	banglos	unwurn	unwurn	kolar	kolar	kender	kender	n	4 = switch, response change
45	party	party	member	member	doctor	doctor	image	image	w	2 = nonswitch, response change
46	턱뜬	teoktton	센닥	sendak	빈미	binmi	린갑	ringap	n	4 = switch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
47	센민	senmin	껴니	kkyeoni	쳅똔	cheptton	헨밸	henbael	n	1= nonswitch, repetition
48	테힐	tehil	거뒹	geodwing	콰너	kwaneo	베쩌	bejjeo	n	1= nonswitch, repetition
49	office	office	power	power	question	question	second	second	w	4 = switch, response change
50	colob	colob	chorax	chorax	scoved	scoved	agrials	agrials	n	2 = nonswitch, response change
51	report	report	market	market	table	table	factor	factor	w	2 = nonswitch, response change
52	거뒹	geodwing	뒹민	dwingmin	헨밸	henbael	헨메	henme	n	4 = switch, response change
53	banper	banper	pagnum	pagnum	nello	nello	winber	winber	n	3 = switch, repetition
54	detail	detail	feeling	feeling	effect	effect	power	power	w	2 = nonswitch, response change
55	산업	saneop	대화	daehwa	담배	dambae	시간	sigan	w	3 = switch, repetition
56	series	series	money	money	response	response	meeting	meeting	w	3 = switch, repetition
57	mausage	mausage	glottil	glottil	sarpon	sarpon	embang	embang	n	2 = nonswitch, response change
58	season	season	music	music	option	option	million	million	w	2 = nonswitch, response change
59	사진	sajin	나무	namu	한참	hancham	필요	pilyo	w	3 = switch, repetition
60	궈러	gworeo	처포	cheopo	느조	neujo	잔닌	jannin	n	2 = nonswitch, response change
61	player	player	parent	parent	sister	sister	comment	comment	w	4 = switch, response change
62	사회	sahoe	마을	maeul	내용	naeyong	현실	hyeonsil	w	3 = switch, repetition
63	밸포	baelpo	케쩌	kejjeo	껴니	kkyeoni	쥬둔	jyudun	n	2 = nonswitch, response change
64	내일	naeil	담배	dambae	시간	sigan	교육	gyoyuk	w	2 = nonswitch, response change
65	정신	jeongsin	지금	jigeum	대표	daepyo	선거	seongeo	w	1= nonswitch, repetition
66	govers	govers	abards	abards	placif	placif	olphan	olphan	n	4 = switch, response change
67	feasants	feasants	judgen	judgen	cailboats	cailboats	quotu	quotu	n	1= nonswitch, repetition
68	베쿠	beku	밸포	baelpo	텀심	teomsim	너미	neomi	n	3 = switch, repetition
69	meeting	meeting	resource	resource	party	party	movement	movement	w	4 = switch, response change
70	placif	placif	panguid	panguid	wooxen	wooxen	unwurn	unwurn	n	2 = nonswitch, response change
71	yellep	yellep	instrict	instrict	reltas	reltas	uldock	uldock	n	1= nonswitch, repetition

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
72	느바	neuba	샷겔	satgel	멱탕	myeoktang	눌디	nuldi	n	3 = switch, repetition
73	물건	mulgeon	회사	hoesa	생활	saenghwal	경제	gyeongje	w	2 = nonswitch, response change
74	내용	naeyong	중심	jungsim	사진	sajin	그림	geurim	w	1= nonswitch, repetition
75	feports	feports	rawyer	rawyer	hallots	hallots	glamog	glamog	n	4 = switch, response change
76	cashion	cashion	sarpon	sarpon	harnings	harnings	pokens	pokens	n	1= nonswitch, repetition
77	잔닌	jannin	넬궈	nelgwo	펴거	pyeogeo	루찌	rujji	n	3 = switch, repetition
78	처쥬	cheojyu	턱겔	teokgel	거쪄	geojjeo	빔턱	bimteok	n	1= nonswitch, repetition
79	section	section	practice	practice	system	system	market	market	w	4 = switch, response change
80	summer	summer	approach	approach	service	service	morning	morning	w	1= nonswitch, repetition
81	노래	norae	물건	mulgeon	순간	sungan	국가	gukga	w	3 = switch, repetition
82	떠밧	tteobat	텀심	teomsim	쩌럭	jjeoreok	미쥬	mijyu	n	2 = nonswitch, response change
83	떠눌	tteonul	니중	nijung	헨처	hencheo	빈미	binmi	n	1= nonswitch, repetition
84	letter	letter	version	version	money	money	river	river	w	4 = switch, response change
85	artist	artist	effect	effect	concern	concern	party	party	w	1= nonswitch, repetition
86	second	second	table	table	defense	defense	reason	reason	w	1= nonswitch, repetition
87	서빌	seobil	베쿠	beku	턱끄	teokkeu	펴거	pyeogeo	n	4 = switch, response change
88	enlosts	enlosts	uldock	uldock	favel	favel	sarpon	sarpon	n	3 = switch, repetition
89	시간	sigan	대표	daepyo	마을	maeul	마음	maeum	w	4 = switch, response change
90	resource	resource	program	program	summer	summer	effect	effect	w	3 = switch, repetition
91	턱겔	teokgel	헨처	hencheo	첨쿠	cheomku	밉센	mipsen	n	4 = switch, response change
92	밉센	mipsen	겔밉	gelmip	센닥	sendak	미턱	miteok	n	1= nonswitch, repetition
93	nylaw	nylaw	ibward	ibward	jissolve	jissolve	instrict	instrict	n	3 = switch, repetition
94	가정	gajeong	상황	sanghwang	가치	gachi	머리	meori	w	4 = switch, response change
95	자신	jasin	기슬	giseul	표정	pyojeong	정치	jeongchi	w	1= nonswitch, repetition
96	머리	meori	아들	adeul	손님	sonnim	오늘	oneul	w	1= nonswitch, repetition
97	instrict	instrict	vorter	vorter	gerby	gerby	cashion	cashion	n	4 = switch, response change
98	센닥	sendak	떠밧	tteobat	밉센	mipsen	트살	teusal	n	3 = switch, repetition
99	오늘	oneul	계획	gyehoek	결과	gyeolgwa	노래	norae	w	2 = nonswitch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
100	마음	maeum	가정	gajeong	결혼	gyeolhon	시험	siheom	w	1= nonswitch, repetition
101	design	design	body	body	building	building	daughter	daughter	w	3 = switch, repetition
102	정도	jeongdo	시험	siheom	정신	jeongsin	하늘	haneul	w	3 = switch, repetition
103	imsue	imsue	briskel	briskel	halrus	halrus	jissolve	jissolve	n	4 = switch, response change
104	nello	nello	eggthell	eggthell	briskel	briskel	krockout	krockout	n	1= nonswitch, repetition
105	future	future	summer	summer	percent	percent	series	series	w	2 = nonswitch, response change
106	사건	sageon	관심	gwansim	학생	haksaeng	기슬	giseul	w	3 = switch, repetition
107	data	data	sister	sister	method	method	letter	letter	w	3 = switch, repetition
108	agent	agent	minute	minute	impact	impact	sister	sister	w	1= nonswitch, repetition
109	lanceg	lanceg	favel	favel	batrol	batrol	hayon	hayon	n	2 = nonswitch, response change
110	ablo	ablo	imsue	imsue	daptions	daptions	ibward	ibward	n	1= nonswitch, repetition
111	콰뜬	kwatton	힐려	hilryeo	쳅심	chepsim	트꺼	teukkeo	n	3 = switch, repetition
112	문화	munhwa	머리	meori	운동	undong	정보	jeongbo	w	2 = nonswitch, response change
113	fectar	fectar	agrials	agrials	mausage	mausage	hanget	hanget	n	4 = switch, response change
114	sister	sister	comment	comment	office	office	author	author	w	2 = nonswitch, response change
115	상황	sanghwang	양반	yangban	과학	gwahak	대학	daehak	w	3 = switch, repetition
116	학생	haksaeng	결과	gyeolgwa	지방	jibang	발전	baljeon	w	1= nonswitch, repetition
117	eggthell	eggthell	harnings	harnings	paxim	paxim	oltet	oltet	n	4 = switch, response change
118	question	question	color	color	meeting	meeting	answer	answer	w	2 = nonswitch, response change
119	duno	duno	gealer	gealer	govers	govers	liarp	liarp	n	2 = nonswitch, response change
120	역사	yeoksa	얼굴	eolgul	발전	baljeon	환자	hwanja	w	4 = switch, response change
121	환자	hwanja	현실	hyeonsil	모양	moyang	생각	saenggak	w	1= nonswitch, repetition
122	defense	defense	future	future	dollar	dollar	story	story	w	3 = switch, repetition
123	luffin	luffin	telper	telper	sazer	sazer	banper	banper	n	2 = nonswitch, response change
124	쥬둔	jyudun	힐빔	hilbim	둑삐	dukppi	첨할	cheomhal	n	3 = switch, repetition
125	쳅심	chepsim	눌디	nuldi	잔닌	jannin	썬하	sseonha	n	1= nonswitch, repetition

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
126	전화	jeonhwa	시대	sidae	지금	jigeum	상황	sanghwang	w	2 = nonswitch, response change
127	빔턱	bimteok	펴노	pyeono	찌콰	jjikwa	쳅똔	cheptton	n	2 = nonswitch, response change
128	ildent	ildent	mausage	mausage	umbound	umbound	otjects	otjects	n	3 = switch, repetition
129	reason	reason	dollar	dollar	career	career	statement	statement	w	2 = nonswitch, response change
130	river	river	project	project	mother	mother	adult	adult	w	1= nonswitch, repetition
131	대표	daepyo	친구	chingu	입장	ipjang	상태	sangtae	w	3 = switch, repetition
132	deaver	deaver	embang	embang	daping	daping	jolgy	jolgy	n	4 = switch, response change
133	latient	latient	otjects	otjects	unwurn	unwurn	halrus	halrus	n	1= nonswitch, repetition
134	하늘	haneul	사실	sasil	내일	naeil	자연	jayeon	w	4 = switch, response change
135	사랑	sarang	하늘	haneul	산업	saneop	양반	yangban	w	1= nonswitch, repetition
136	회사	hoesa	관계	gwangye	사실	sasil	나무	namu	w	1= nonswitch, repetition
137	otjects	otjects	refal	refal	welleg	welleg	yellep	yellep	n	4 = switch, response change
138	gealer	gealer	banglos	banglos	enlosts	enlosts	colob	colob	n	1= nonswitch, repetition
139	현실	hyeonsil	교육	gyoyuk	작업	jageop	자신	jasin	w	4 = switch, response change
140	따테	ttate	빌균	bilgyun	진테	jinte	살힐	salhil	n	2 = nonswitch, response change
141	선거	seongeo	한참	hancham	음식	eumsik	모양	moyang	w	2 = nonswitch, response change
142	factor	factor	product	product	market	market	minute	minute	w	3 = switch, repetition
143	event	event	window	window	statement	statement	people	people	w	1= nonswitch, repetition
144	눌디	nuldi	할찌	haljji	힐려	hilryeo	파궈	pagwo	n	4 = switch, response change
145	펴노	pyeono	따빌	ttabil	마쳐	macheo	떠밧	tteobat	n	1= nonswitch, repetition
146	dumid	dumid	placif	placif	olphan	olphan	imsue	imsue	n	3 = switch, repetition
147	telper	telper	trillborn	trillborn	agrials	agrials	dathers	dathers	n	1= nonswitch, repetition
148	바람	baram	산업	saneop	대화	daehwa	눈물	nunmul	w	4 = switch, response change
149	취파	chwipa	삭뱅	sakbaeng	니중	nijung	민빌	minbil	n	2 = nonswitch, response change
150	밉빔	mipbim	루찌	rujji	트모	teumo	삿겔	satgel	n	1= nonswitch, repetition
151	대화	daehwa	학생	haksaeng	역사	yeoksa	사회	sahoe	w	2 = nonswitch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
152	neddle	neddle	cailboats	cailboats	pokens	pokens	beaty	beaty	n	4 = switch, response change
153	chorax	chorax	batrol	batrol	bankel	bankel	ceelings	ceelings	n	1= nonswitch, repetition
154	jolgy	jolgy	ashletes	ashletes	banper	banper	lanceg	lanceg	n	1= nonswitch, repetition
155	트모	teumo	꾸삭	kkusak	센민	senmin	텍겔	teokgel	n	3 = switch, repetition
156	theory	theory	father	father	language	language	city	city	w	4 = switch, response change
157	트꺼	teukkeo	투회	tuhoe	꾸삭	kkusak	멱탕	myeoktang	n	4 = switch, response change
158	bankel	bankel	welleg	welleg	jolgy	jolgy	cajore	cajore	n	3 = switch, repetition
159	order	order	support	support	letter	letter	husband	husband	w	2 = nonswitch, response change
160	사실	sasil	오늘	oneul	머리	meori	저녁	jeonyeok	w	3 = switch, repetition
161	husband	husband	order	order	river	river	doctor	doctor	w	3 = switch, repetition
162	센벽	senbyeok	디마	dima	취파	chwipa	쳅심	chepsim	n	4 = switch, response change
163	말씀	malsseum	대회	daehoe	하늘	haneul	손님	sonnim	w	2 = nonswitch, response change
164	author	author	model	model	second	second	percent	percent	w	3 = switch, repetition
165	지방	jibang	생각	saenggak	영화	yeonghwa	지금	jigeum	w	3 = switch, repetition
166	batrol	batrol	ilsight	ilsight	dathers	dathers	panguid	panguid	n	4 = switch, response change
167	헨처	hencheo	따테	ttate	파궈	pagwo	꺼루	kkeoru	n	3 = switch, repetition
168	시험	siheom	내용	naeyong	상태	sangtae	전체	jeonche	w	2 = nonswitch, response change
169	answer	answer	action	action	support	support	project	project	w	3 = switch, repetition
170	삿모	satmo	콰뜬	kwatton	썬하	sseonha	케쪄	kejjeo	n	4 = switch, response change
171	campaign	campaign	data	data	report	report	woman	woman	w	4 = switch, response change
172	support	support	theory	theory	parent	parent	question	question	w	1= nonswitch, repetition
173	끄헨	kkeuhen	콰너	kwaneo	밸포	baelpo	메센	mesen	n	4 = switch, response change
174	발전	baljeon	역할	yeokhal	모습	moseup	정도	jeongdo	w	2 = nonswitch, response change
175	father	father	system	system	movement	movement	treatment	treatment	w	3 = switch, repetition
176	music	music	daughter	daughter	image	image	detail	detail	w	1= nonswitch, repetition
177	comment	comment	player	player	million	million	region	region	w	1= nonswitch, repetition
178	daping	daping	latient	latient	anple	anple	nylaw	nylaw	n	2 = nonswitch, response change
179	음식	eumsik	정보	jeongbo	관심	gwansim	소리	sori	w	4 = switch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
180	눈물	nunmul	생활	saenghwal	경우	gyeongu	문화	munhwa	w	1= nonswitch, repetition
181	version	version	report	report	police	police	theory	theory	w	3 = switch, repetition
182	gasteful	gasteful	nello	nello	otjects	otjects	enlosts	enlosts	n	2 = nonswitch, response change
183	olphan	olphan	cajore	cajore	abards	abards	hallots	hallots	n	1= nonswitch, repetition
184	beetroob	beetroob	scoved	scoved	necline	necline	welleg	welleg	n	1= nonswitch, repetition
185	지금	jigeum	표정	pyojeong	신문	sinmun	내용	naeyong	w	4 = switch, response change
186	winber	winber	bankel	bankel	ainport	ainport	gealer	gealer	n	4 = switch, response change
187	힐모	hilmo	텈빌	teokbil	펴노	pyeono	텈똔	teoktton	n	3 = switch, repetition
188	daptions	daptions	ainport	ainport	latient	latient	wooxen	wooxen	n	3 = switch, repetition
189	model	model	agent	agent	story	story	mother	mother	w	2 = nonswitch, response change
190	dathers	dathers	jolgy	jolgy	instrict	instrict	ildent	ildent	n	2 = nonswitch, response change
191	아들	adeul	결혼	gyeolhon	그림	geurim	과학	gwahak	w	4 = switch, response change
192	한참	hancham	상태	sangtae	상황	sanghwang	연구	yeongu	w	1= nonswitch, repetition
193	헨밸	henbael	밉센	mipsen	꺼루	kkeoru	콰너	kwaneo	n	2 = nonswitch, response change
194	ilsight	ilsight	ramblet	ramblet	ablo	ablo	ashletes	ashletes	n	3 = switch, repetition
195	국가	gukga	전체	jeonche	선거	seongeo	영화	yeonghwa	w	4 = switch, response change
196	power	power	party	party	member	member	window	window	w	3 = switch, repetition
197	하루	haru	단체	danche	시대	sidae	결과	gyeolgwa	w	3 = switch, repetition
198	mecan	mecan	hayon	hayon	quotu	quotu	telper	telper	n	4 = switch, response change
199	투회	tuhoe	빈미	binmi	삭뱅	sakbaeng	심멱	simmyeok	n	3 = switch, repetition
200	effect	effect	answer	answer	body	body	dollar	dollar	w	4 = switch, response change
201	paxim	paxim	hanget	hanget	feports	feports	abards	abards	n	2 = nonswitch, response change
202	쳅똔	cheptton	궈러	gworeo	힐밸	hilbael	찌콰	jjikwa	n	3 = switch, repetition
203	펴거	pyeogeo	심멱	simmyeok	미쥬	mijyu	꾸삭	kkusak	n	1= nonswitch, repetition
204	sarnish	sarnish	pokens	pokens	oltet	oltet	fectar	fectar	n	3 = switch, repetition
205	사장	sajang	노래	norae	물건	mulgeon	사랑	sarang	w	4 = switch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
206	힐빔	hilbim	처쥬	cheojyu	턱겔	teokgel	센닥	sendak	n	2 = nonswitch, response change
207	doctor	doctor	factor	factor	message	message	success	success	w	4 = switch, response change
208	모양	moyang	세상	sesang	문학	munhak	모습	moseup	w	3 = switch, repetition
209	wooxen	wooxen	necline	necline	zeroid	zeroid	glottil	glottil	n	4 = switch, response change
210	시민	simin	사건	sageon	문화	munhwa	학교	hakgyo	w	4 = switch, response change
211	썬하	sseonha	센민	senmin	센벽	senbyeok	귕턱	gwingteok	n	2 = nonswitch, response change
212	approach	approach	level	level	adult	adult	music	music	w	4 = switch, response change
213	트살	teusal	민빌	minbil	꾸거	kkugeo	군휘	gunhwi	n	4 = switch, response change
214	멱탕	myeoktang	트꺼	teukkeo	디마	dima	꾸거	kkugeo	n	1= nonswitch, repetition
215	둑삐	dukppi	느조	neujo	뒹민	dwingmin	거쿠	geoku	n	1= nonswitch, repetition
216	양반	yangban	마음	maeum	사장	sajang	표정	pyojeong	w	2 = nonswitch, response change
217	sarpon	sarpon	reltas	reltas	ibward	ibward	chorax	chorax	n	4 = switch, response change
218	glottil	glottil	winber	winber	vorter	vorter	ainport	ainport	n	1= nonswitch, repetition
219	people	people	artist	artist	network	network	impact	impact	w	2 = nonswitch, response change
220	member	member	meeting	meeting	union	union	money	money	w	1= nonswitch, repetition
221	진테	jinte	할너	halneo	베쩌	bejjeo	처포	cheopo	n	4 = switch, response change
222	삭빌	sakbil	진테	jinte	콰똔	kwatton	력끄	ryeokkeu	n	1= nonswitch, repetition
223	unwurn	unwurn	lanceg	lanceg	ticeps	ticeps	scoved	scoved	n	3 = switch, repetition
224	콰너	kwaneo	턱끄	teokkeu	떠눌	tteonul	니중	nijung	n	3 = switch, repetition
225	정치	jeongchi	학교	hakgyo	기슬	giseul	사실	sasil	w	2 = nonswitch, response change
226	sazer	sazer	dumid	dumid	duno	duno	ablo	ablo	n	4 = switch, response change
227	미쥬	mijyu	뒹가	dwingga	삭빌	sakbil	따빌	ttabil	n	3 = switch, repetition
228	manper	manper	halrus	halrus	beetroob	beetroob	deaver	deaver	n	3 = switch, repetition
229	action	action	movement	movement	daughter	daughter	father	father	w	2 = nonswitch, response change
230	dollar	dollar	study	study	practice	practice	action	action	w	1= nonswitch, repetition
231	경우	gyeongu	말씀	malsseum	고향	gohyang	과거	gwageo	w	3 = switch, repetition

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
232	뒹가	dwingga	멱탕	myeoktang	바찌	bajji	둔거	dungeo	n	2 = nonswitch, response change
233	케쩌	kejjeo	삿모	satmo	둔거	dungeo	밸포	baelpo	n	1= nonswitch, repetition
234	percent	percent	million	million	region	region	building	building	w	4 = switch, response change
235	ibward	ibward	beetroob	beetroob	judgen	judgen	rupa	rupa	n	2 = nonswitch, response change
236	kender	kender	mecan	mecan	refal	refal	gerby	gerby	n	1= nonswitch, repetition
237	살힐	salhil	려끄	ryeokkeu	군휘	gunhwi	느조	neujo	n	3 = switch, repetition
238	나무	namu	고향	gohyang	저녁	jeonyeok	사진	sajin	w	2 = nonswitch, response change
239	concern	concern	detail	detail	artist	artist	section	section	w	3 = switch, repetition
240	소설	soseol	전화	jeonhwa	자연	jayeon	운동	undong	w	3 = switch, repetition
241	cajore	cajore	nylaw	nylaw	gasteful	gasteful	beetroob	beetroob	n	4 = switch, response change
242	morning	morning	record	record	minute	minute	couple	couple	w	2 = nonswitch, response change
243	quotu	quotu	yellep	yellep	cajore	cajore	vorter	vorter	n	2 = nonswitch, response change
244	거쩌	geojjeo	첨쿠	cheomku	메센	mesen	바찌	bajji	n	3 = switch, repetition
245	관심	gwansim	자연	jayeon	중심	jungsim	사건	sageon	w	2 = nonswitch, response change
246	level	level	amount	amount	music	music	career	career	w	3 = switch, repetition
247	ramblet	ramblet	kender	kender	ashletes	ashletes	cailboats	cailboats	n	2 = nonswitch, response change
248	기능	gineung	정도	jeongdo	문제	munje	대회	daehoe	w	4 = switch, response change
249	시대	sidae	대학	daehak	교육	gyoyuk	말씀	malsseum	w	1= nonswitch, repetition
250	영화	yeonghwa	시간	sigan	노래	norae	단체	danche	w	1= nonswitch, repetition
251	힐려	hilryeo	힐밸	hilbael	루찌	rujji	할찌	haljji	n	2 = nonswitch, response change
252	헨메	henme	너미	neomi	귕턱	gwingteok	뒹가	dwingga	n	1= nonswitch, repetition
253	network	network	defense	defense	future	future	police	police	w	4 = switch, response change
254	살밸	salbael	살힐	salhil	뒹가	dwingga	키더	kideo	n	4 = switch, response change
255	휘조	hwijo	쩌럭	jjeoreok	느바	neuba	따테	ttate	n	1= nonswitch, repetition
256	water	water	concern	concern	season	season	summer	summer	w	4 = switch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
257	police	police	campaign	campaign	level	level	future	future	w	1= nonswitch, repetition
258	교육	gyoyuk	정치	jeongchi	환자	hwanja	사장	sajang	w	3 = switch, repetition
259	턱끄	teokkeu	떠눌	tteonul	거됭	geodwing	됭민	dwingmin	n	2 = nonswitch, response change
260	career	career	image	image	reason	reason	feeling	feeling	w	4 = switch, response change
261	얼굴	eolgul	신문	sinmun	역할	yeokhal	역사	yeoksa	w	3 = switch, repetition
262	자연	jayeon	국가	gukga	하루	haru	문제	munje	w	1= nonswitch, repetition
263	미턱	miteok	둑삐	dukppi	트살	teusal	트모	teumo	n	2 = nonswitch, response change
264	cailboats	cailboats	kolar	kolar	jestle	jestle	tandits	tandits	n	3 = switch, repetition
265	hanget	hanget	deaver	deaver	ildent	ildent	daping	daping	n	1= nonswitch, repetition
266	마처	macheo	거쿠	geoku	처포	cheopo	서빌	seobil	n	3 = switch, repetition
267	window	window	husband	husband	disease	disease	member	member	w	4 = switch, response change
268	교수	gyosu	가치	gachi	눈물	nunmul	가정	gajeong	w	3 = switch, repetition
269	담배	dambae	기능	gineung	집단	jipdan	물건	mulgeon	w	1= nonswitch, repetition
270	테키	teki	첸심	chepsim	서빌	seobil	잔린	janrin	n	2 = nonswitch, response change
271	문제	munje	환자	hwanja	가정	gajeong	하루	haru	w	2 = nonswitch, response change
272	parent	parent	morning	morning	event	event	option	option	w	3 = switch, repetition
273	느조	neujo	힐모	hilmo	거쿠	geoku	펴노	pyeono	n	4 = switch, response change
274	마을	maeul	자신	jasin	시민	simin	노력	noryeok	w	2 = nonswitch, response change
275	decade	decade	message	message	color	color	office	office	w	3 = switch, repetition
276	movement	movement	option	option	power	power	business	business	w	1= nonswitch, repetition
277	찌콰	jjikwa	잔닌	jannin	힐빔	hilbim	센민	senmin	n	4 = switch, response change
278	텀심	teomsim	첨할	cheomhal	잔린	janrin	넬궈	nelgwo	n	1= nonswitch, repetition
279	daughter	daughter	mother	mother	product	product	agent	agent	w	4 = switch, response change
280	feeling	feeling	office	office	husband	husband	program	program	w	1= nonswitch, repetition
281	손님	sonnim	문화	munhwa	대회	daehoe	시민	simin	w	3 = switch, repetition
282	입장	ipjang	운동	undong	전체	jeonche	신문	sinmun	w	1= nonswitch, repetition

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
283	려끄	ryeokkeu	키더	kideo	따빌	ttabil	할너	halneo	n	2 = nonswitch, response change
284	세상	sesang	사랑	sarang	바람	baram	소설	soseol	w	2 = nonswitch, response change
285	anple	anple	liarp	liarp	uldock	uldock	umbound	umbound	n	4 = switch, response change
286	ticeps	ticeps	efter	efter	nylaw	nylaw	placif	placif	n	1= nonswitch, repetition
287	대학	daehak	하루	haru	나무	namu	순간	sungan	w	4 = switch, response change
288	소리	sori	저녁	jeonyeok	정보	jeongbo	관심	gwansim	w	1= nonswitch, repetition
289	첨쿠	cheomku	군휘	gunhwi	끄헨	kkeuhen	거빌	geobil	n	2 = nonswitch, response change
290	table	table	series	series	people	people	event	event	w	4 = switch, response change
291	city	city	story	story	series	series	system	system	w	1= nonswitch, repetition
292	kolar	kolar	feasants	feasants	banglos	banglos	manper	manper	n	2 = nonswitch, response change
293	message	message	subject	subject	campaign	campaign	data	data	w	2 = nonswitch, response change
294	너미	neomi	쥬둔	jyudun	려끄	ryeokkeu	처쥬	cheojyu	n	4 = switch, response change
295	minute	minute	union	union	model	model	response	response	w	4 = switch, response change
296	경제	gyeongje	그림	geurim	학교	hakgyo	기능	gineung	w	3 = switch, repetition
297	service	service	adult	adult	subject	subject	attack	attack	w	3 = switch, repetition
298	바찌	bajji	거빌	geobil	따테	ttate	휘조	hwijo	n	4 = switch, response change
299	파궈	pagwo	찌콰	jjikwa	쥬둔	jyudun	궈러	gworeo	n	1= nonswitch, repetition
300	abards	abards	zeroid	zeroid	glottil	glottil	batrol	batrol	n	3 = switch, repetition
301	language	language	event	event	treatment	treatment	service	service	w	2 = nonswitch, response change
302	껴니	kkyeoni	거쩌	geojjeo	궈러	gworeo	빌균	bilgyun	n	4 = switch, response change
303	삭뱅	sakbaeng	꺼루	kkeoru	베쿠	beku	힐려	hilryeo	n	1= nonswitch, repetition
304	작업	jageop	순간	sungan	기능	gineung	교수	gyosu	w	2 = nonswitch, response change
305	couple	couple	region	region	city	city	study	study	w	3 = switch, repetition
306	color	color	section	section	version	version	amount	amount	w	1= nonswitch, repetition
307	building	building	network	network	father	father	model	model	w	1= nonswitch, repetition
308	hallots	hallots	beaty	beaty	mecan	mecan	ilsight	ilsight	n	2 = nonswitch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
309	할너	halneo	균밉	gyunmip	밉빔	mipbim	진테	jinte	n	3 = switch, repetition
310	가치	gachi	문학	munhak	아들	adeul	결혼	gyeolhon	w	2 = nonswitch, response change
311	statement	statement	season	season	record	record	campaign	campaign	w	3 = switch, repetition
312	uldock	uldock	glamog	glamog	deaver	deaver	rawyer	rawyer	n	2 = nonswitch, response change
313	운동	undong	노력	noryeok	시험	siheom	계획	gyehoek	w	4 = switch, response change
314	judgen	judgen	rupa	rupa	luffin	luffin	latient	latient	n	4 = switch, response change
315	할찌	haljji	빔턱	bimteok	휘조	hwijo	겔밉	gelmip	n	3 = switch, repetition
316	단체	danche	눈물	nunmul	대학	daehak	지방	jibang	w	2 = nonswitch, response change
317	kervish	kervish	daptions	daptions	pagnum	pagnum	jestle	jestle	n	4 = switch, response change
318	region	region	response	response	theory	theory	union	union	w	2 = nonswitch, response change
319	market	market	water	water	answer	answer	language	language	w	1= nonswitch, repetition
320	심멱	simmyeok	잔린	janrin	턱빌	teokbil	삭뱅	sakbaeng	n	4 = switch, response change
321	빌균	bilgyun	서빌	seobil	할너	halneo	취파	chwipa	n	1= nonswitch, repetition
322	harnings	harnings	hallots	hallots	telper	telper	govers	govers	n	3 = switch, repetition
323	estras	estras	sazer	sazer	ilsight	ilsight	mausage	mausage	n	1= nonswitch, repetition
324	과거	gwageo	손님	sonnim	세상	sesang	고향	gohyang	w	4 = switch, response change
325	문학	munhak	과거	gwageo	정도	jeongdo	친구	chingu	w	1= nonswitch, repetition
326	넬궈	nelgwo	린갑	ringap	삿모	satmo	콰똔	kwatton	n	2 = nonswitch, response change
327	study	study	couple	couple	program	program	artist	artist	w	4 = switch, response change
328	pagnum	pagnum	jestle	jestle	imsue	imsue	necline	necline	n	2 = nonswitch, response change
329	umbound	umbound	kervish	kervish	rupa	rupa	duno	duno	n	1= nonswitch, repetition
330	favel	favel	fectar	fectar	sarnish	sarnish	ramblet	ramblet	n	1= nonswitch, repetition
331	상태	sangtae	모양	moyang	친구	chingu	문학	munhak	w	4 = switch, response change
332	계획	gyehoek	사장	sajang	얼굴	eolgul	작업	jageop	w	1= nonswitch, repetition
333	턱빌	teokbil	펴거	pyeogeo	살뱁	salbael	투회	tuhoe	n	2 = nonswitch, response change
334	rupa	rupa	gasteful	gasteful	gealer	gealer	trillborn	trillborn	n	3 = switch, repetition

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
335	panguid	panguid	feports	feports	hayon	hayon	zeroid	zeroid	n	1= nonswitch, repetition
336	필요	pilyo	경제	gyeongje	생각	saenggak	회사	hoesa	w	4 = switch, response change
337	impact	impact	disease	disease	success	success	table	table	w	3 = switch, repetition
338	woman	woman	doctor	doctor	decade	decade	disease	disease	w	1= nonswitch, repetition
339	zeroid	zeroid	olphan	olphan	efter	efter	daptions	daptions	n	2 = nonswitch, response change
340	jestle	jestle	neddle	neddle	liarp	liarp	paxim	paxim	n	1= nonswitch, repetition
341	뒹민	dwingmin	미턱	miteok	키더	kideo	살밸	salbael	n	3 = switch, repetition
342	rawyer	rawyer	gerby	gerby	cashion	cashion	judgen	judgen	n	3 = switch, repetition
343	disease	disease	woman	woman	window	window	version	version	w	2 = nonswitch, response change
344	루찌	rujji	마처	macheo	넬궈	nelgwo	텀심	teomsim	n	4 = switch, response change
345	린갑	ringap	살밸	salbael	살힐	salhil	첨쿠	cheomku	n	1= nonswitch, repetition
346	hayon	hayon	luffin	luffin	glamog	glamog	efter	efter	n	3 = switch, repetition
347	관계	gwangye	교수	gyosu	오늘	oneul	한참	hancham	w	4 = switch, response change
348	빈미	binmi	삭빌	sakbil	겔밉	gelmip	디마	dima	n	2 = nonswitch, response change
349	vorter	vorter	ceelings	ceelings	estras	estras	mecan	mecan	n	3 = switch, repetition
350	body	body	city	city	approach	approach	practice	practice	w	2 = nonswitch, response change
351	정보	jeongbo	작업	jageop	계획	gyehoek	중심	jungsim	w	3 = switch, repetition
352	mother	mother	language	language	agent	agent	paper	paper	w	3 = switch, repetition
353	subject	subject	career	career	resource	resource	report	report	w	1= nonswitch, repetition
354	pokens	pokens	cashion	cashion	neddle	neddle	bankel	bankel	n	2 = nonswitch, response change
355	저녁	jeonyeok	지방	jibang	연구	yeongu	정신	jeongsin	w	4 = switch, response change
356	삿겔	satgel	밉빔	mipbim	심멱	simmyeok	힐모	hilmo	n	2 = nonswitch, response change
357	refal	refal	paxim	paxim	panguid	panguid	neddle	neddle	n	3 = switch, repetition
358	adult	adult	river	river	section	section	decade	decade	w	2 = nonswitch, response change
359	표정	pyojeong	발전	baljeon	자신	jasin	음식	eumsik	w	3 = switch, repetition
360	ashletes	ashletes	enlosts	enlosts	ramblet	ramblet	estras	estras	n	4 = switch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
361	product	product	police	police	study	study	level	level	w	2 = nonswitch, response change
362	전체	jeonche	내일	naeil	회사	hoesa	관계	gwangye	w	3 = switch, repetition
363	거쿠	geoku	테힐	tehil	트꺼	teukkeo	베쿠	beku	n	2 = nonswitch, response change
364	키더	kideo	트살	teusal	민빌	minbil	턱끄	teokkeu	n	1= nonswitch, repetition
365	메센	mesen	바찌	bajji	거빌	geobil	턱빌	teokbil	n	1= nonswitch, repetition
366	story	story	statement	statement	action	action	support	support	w	4 = switch, response change
367	krockout	krockout	ablo	ablo	fectar	fectar	refal	refal	n	2 = nonswitch, response change
368	amount	amount	method	method	paper	paper	resource	resource	w	2 = nonswitch, response change
369	집단	jipdan	문제	munje	마음	maeum	바람	baram	w	3 = switch, repetition
370	million	million	people	people	feeling	feeling	water	water	w	3 = switch, repetition
371	gerby	gerby	oltet	oltet	kervish	kervish	briskel	briskel	n	2 = nonswitch, response change
372	jissolve	jissolve	tandits	tandits	dumid	dumid	gasteful	gasteful	n	1= nonswitch, repetition
373	program	program	second	second	project	project	concern	concern	w	2 = nonswitch, response change
374	ceelings	ceelings	jissolve	jissolve	trillborn	trillborn	sarnish	sarnish	n	2 = nonswitch, response change
375	거빌	geobil	취파	chwipa	케쩌	kejjeo	껴니	kkyeoni	n	3 = switch, repetition
376	힐밸	hilbael	끄헨	kkeuhen	할찌	haljji	균밉	gyunmip	n	1= nonswitch, repetition
377	신문	sinmun	과학	gwahak	현실	hyeonsil	대표	daepyo	w	2 = nonswitch, response change
378	순간	sungan	필요	pilyo	교수	gyosu	가치	gachi	w	1= nonswitch, repetition
379	practice	practice	question	question	comment	comment	approach	approach	w	3 = switch, repetition
380	결혼	gyeolhon	선거	seongeo	소리	sori	생활	saenghwal	w	3 = switch, repetition
381	꾸삭	kkusak	헨메	henme	눌디	nuldi	느바	neuba	n	2 = nonswitch, response change
382	embang	embang	krockout	krockout	kender	kender	anple	anple	n	3 = switch, repetition
383	glamog	glamog	govers	govers	embang	embang	kolar	kolar	n	1= nonswitch, repetition
384	생활	saenghwal	집단	jipdan	정치	jeongchi	역할	yeokhal	w	4 = switch, response change

	List A Hangeul	List A Romanization	List B Hangeul	List B Romanization	List C Hangeul	List C Romanization	List D Hangeul	List D Romanization	Word type	Condition
385	고향	gohyang	바람	baram	사건	sageon	세상	sesang	w	1= nonswitch, repetition
386	균밉	gyunmip	메센	mesen	너미	neomi	헨처	hencheo	n	2 = nonswitch, response change
387	attack	attack	design	design	detail	detail	color	color	w	4 = switch, response change
388	number	number	paper	paper	design	design	message	message	w	1= nonswitch, repetition
389	첨할	cheomhal	궝턱	gwingteok	떠밧	tteobat	삭빌	sakbil	n	4 = switch, response change
390	paper	paper	author	author	business	business	number	number	w	4 = switch, response change
391	method	method	letter	letter	data	data	order	order	w	1= nonswitch, repetition
392	쩌럭	jjeoreok	느바	neuba	빔턱	bimteok	밉빔	mipbim	n	4 = switch, response change
393	연구	yeongu	정신	jeongsin	과거	gwageo	산업	saneop	w	2 = nonswitch, response change
394	학교	hakgyo	역사	yeoksa	노력	noryeok	내일	naeil	w	1= nonswitch, repetition
395	베쩌	bejjeo	파궈	pagwo	첨할	cheomhal	마처	macheo	n	2 = nonswitch, response change
396	option	option	service	service	amount	amount	record	record	w	4 = switch, response change
397	니중	nijung	첩똔	cheptton	삿겔	satgel	힐밸	hilbael	n	4 = switch, response change
398	reltas	reltas	quotu	quotu	feasants	feasants	eggthell	eggthell	n	3 = switch, repetition
399	beaty	beaty	anple	anple	rawyer	rawyer	luffin	luffin	n	1= nonswitch, repetition
400	궝턱	gwingteok	썬하	sseonha	헨메	henme	센벽	senbyeok	n	3 = switch, repetition

Appendix 3: Elicited Imitation Task sentences (English)

1. I have to get a haircut.
2. The red book is on the table.
3. The streets in this city are wide.
4. He takes a shower every morning.
5. What did you say you were doing today?
6. I doubt that he knows how to drive that well.
7. After dinner I had a long, peaceful nap.
8. It is possible that it will rain tomorrow.
9. I enjoy movies which have a happy ending.
10. The houses are very nice but too expensive.
11. The little boy whose kitten died yesterday is sad.
12. That restaurant is supposed to have very good food.
13. I want a nice, big house in which my animals can live.
14. You really enjoy listening to country music, don't you.
15. She just finished painting the inside of her apartment.
16. Cross the street at the light and then just continue straight ahead.
17. The person I'm dating has a wonderful sense of humor.
18. She only orders meat dishes and never eats vegetables.
19. I wish the price of town houses would become affordable.
20. I hope it will get warmer sooner this year than it did last year.
21. A good friend of mine always takes care of my neighbor's three children.
22. The black cat that you fed yesterday was the one chased by the dog.
23. Before he can go outside, he has to finish cleaning his room.
24. The most fun I've ever had was when we went to the opera.
25. The terrible thief whom the police caught was very tall and thin.
26. Would you be so kind as to hand me the book which is on the table?
27. The number of people who smoke cigars is increasing every year.
28. I don't know if the 11:30 train has left the station yet.
29. The exam wasn't nearly as difficult as you told me it would be.
30. There are a lot of people who don't eat anything at all in the morning.

Appendix 4: English cloze test

MAN AND HIS PROGRESS

Man is the only living creature that can make and use tools. He is the most teachable of living beings, earning the name of Homo sapiens. (1) ____ ever restless brain has used the (2) and the wisdom of his ancestors (3) ____ improve his way of life. Since (4) ____ is able to walk and run (5) ____ his feet, his hands have always (6) ____ free to carry and to use (7) ____ . Man's hands have served him well (8) ____ his life on earth. His development, (9) ____ can be divided into three major (10) ____, is marked by several different ways (11) ____ life.

Up to 10,000 years ago, (12) ____ human beings lived by hunting and (13) ____. They also picked berries and fruits, (14) ____ dug for various edible roots. Most (15) ____, the men were the hunters, and (16) ____ women acted as food gatherers. Since (17) ____ women were busy with the children, (18) ____ men handled the tools. In a (19) ____ hand, a dead branch became a (20) ____ to knock down fruit or (21) ____ for tasty roots. Sometimes, an animal (22) ____ served as a club, and a (23) ____ piece of stone, fitting comfortably into (24) ____ hand, could be used to break (25) ____ or to throw at an animal. (26) ____ stone was chipped against another until (27) ____ had a sharp edge. The primitive (28) ____ who first thought of putting a (29) ____ stone at the end of a (30) ____ made a brilliant discovery: he (31) ____ joined two things to make a (32) ____ useful tool, the spear. Flint, found (33) ____ many rocks, became a common cutting (34) ____ in the Paleolithic period of man's (35) ____. Since no wood or bone tools (36) ____ survived, we know of this man (37) ____ his stone implements, with which he (38) ____ kill animals, cut up the meat, (39) ____ scrape the skins, as well as (40) ____ pictures on the walls of the (41) ____ where he lived during the winter.

(42) ____ the warmer seasons, man wandered on (43) ____ steppes of Europe without a fixed (44) ____, always foraging for food. Perhaps the (45) ____ carried nuts and berries in shells (46) ____ skins or even in light, woven (47) ____ . Wherever they camped, the primitive people (48) ____ fires by striking flint for sparks (49) ____ using dried seeds, moss, and rotten (50) ____ for tinder. With fires that he kindled himself, man could keep wild animals away and could cook those that he killed, as well as provide warmth and light for himself.

Appendix 5: Language background questionnaire

In this questionnaire, we ask for information about the languages you know. We also ask for some basic information about yourself, including your contact information. Please be assured that this information will be kept confidential and will not be shared with anybody.

If you have any questions while completing this questionnaire, please do not hesitate to ask!

Personal information:

Gender (male, female, non-binary):

Current age (years, months):

Place of birth:

Occupation/student status (i.e., full-time/part-time, current year of study):

Your highest degree obtained:

Most recent TOEFL/IELTS/Duolingo score:

Month/year of most recent test date:

Language history:

What was the first language you learned as a child?

What language do you feel most comfortable speaking in casual conversation now?

What language(s) was/were spoken in your home when you were growing up?

What is your mother's native language?

What language(s) did your mother use with you when you were a child?

What is your father's native language?

What language(s) did your father use with you when you were a child?

Please provide date of immigration to the USA, if applicable:

If you have ever lived in (not visited) another country, please provide name of country and dates of stay here:

Language background:

Please list all the languages you know **in order of when you learned them**:

Please list all the languages you know **in order of most to least current use**:

In no particular order, please indicate your overall proficiency level on a scale of 0 (lowest) to 10 (highest) for each language.

Are you familiar with Korean romanization (specifically, the Revised Romanization of Korean)? Please describe your familiarity with Korean romanization.

About your English:

At what age did you start learning English? (If you started at birth, write 0)

If applicable, how long have you studied abroad in America? Please answer in years and months, or provide the semester you started.

Please indicate which language(s) you generally use for the following activities:
___ All English ___ Mostly English ___ Half English Half Korean __ Mostly Korean ___ All Korean

a) At home
b) At school
c) At work
d) Social activities (e.g., hanging out with friends, movies)
e) Religious activities (e.g., church)
f) Extracurricular activities (e.g., hobbies, sports, volunteering)
g) Public/banks/government/health care offices
h) Reading
i) Emailing
j) Texting
k) Social media
l) Writing
m) Watching TV
n) Watching movies

o) Listening to radio/music
p) Browsing the internet

On a scale of 0 to 10 (0: lowest and 10: highest), please rate your ability in English in the following areas:

a) Speaking
b) Understanding spoken language
c) Reading
d) Writing
e) Overall proficiency

I tend to switch languages during a conversation (For example: I switch from Korean to English, or vice versa).
___ never ___ very infrequently ___ occasionally __ frequently ___ always

There are situations in which I always switch between the two languages. ___ yes __ no
If yes, please describe those situations here:

There are certain topics or issues for which I normally switch between the two languages.
___ yes __ no If yes, please describe those topics or issues here:

Do you consider yourself a native speaker of English?

Do native speakers of English think you are a native speaker?

If there is any other information that you would like to share with me, please include it below:

Appendix 6: Counterbalanced task orders (Hangeul)

Naming first (Hangeul)

Participants 1, 17, 33	Participants 2, 18, 34	Participants 3, 19, 35	Participants 4, 20, 36	Participants 5, 21, 37	Participants 6, 22, 38	Participants 23, 39	Participants 8, 24, 40
Consent	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**
Lang questionnaire	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**
Hangeul naming List A	Hangeul naming List A	Hangeul naming List A	Hangeul naming List A	Hangeul naming List B	Hangeul naming List B	Hangeul naming List B	Hangeul naming List B
English Cloze	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**
Hangeul LDT List A	Hangeul LDT List B	Hangeul LDT List C	Hangeul LDT List D	Hangeul LDT List A	Hangeul LDT List B	Hangeul LDT List C	Hangeul LDT List D
English EIT	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**

LDT first (Hangeul)

Participants 9, 25, 41	Participants 10, 26, 42	Participants 11, 27, 43	Participants 12, 28, 44	Participants 13, 29, 45	Participants 14, 30, 46	Participants 15, 31, 47	Participants 16, 32, 48
Consent	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**
Lang questionnaire	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**
Hangeul LDT List A	Hangeul LDT List B	Hangeul LDT List C	Hangeul LDT List D	Hangeul LDT List A	Hangeul LDT List B	Hangeul LDT List C	Hangeul LDT List D
English Cloze	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**
Hangeul naming List A	Hangeul naming List A	Hangeul naming List A	Hangeul naming List A	Hangeul naming List B	Hangeul naming List B	Hangeul naming List B	Hangeul naming List B
English EIT	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**

Appendix 7: Counterbalanced task orders (Korean romanization)

Naming first (Korean romanization)

Participants 49, 65, 81	Participants 50, 66, 82	Participants 51, 67, 83	Participants 52, 68, 84	Participants 53, 69, 85	Participants 54, 70, 86	Participants 55, 71, 87	Participants 56, 72, 88
Consent	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**
Lang questionnaire	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**
Romanization naming List A	Romanization naming List A	Romanization naming List A	Romanization naming List A	Romanization naming List B	Romanization naming List B	Romanization naming List B	Romanization naming List B
English Cloze	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**
Romanization LDT List A	Romanization LDT List B	Romanization LDT List C	Romanization LDT List D	Romanization LDT List A	Romanization LDT List B	Romanization LDT List C	Romanization LDT List D
English EIT	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**

LDT first (Korean romanization)

Participants 57, 73, 89	Participants 58, 74, 90	Participants 59, 75, 91	Participants 60, 76, 92	Participants 61, 77, 93	Participants 62, 78, 94	Participants 63, 79, 95	Participants 64, 80, 96
Consent	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**	**Consent**
Lang questionnaire	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**	**Lang questionnaire**
Romanization LDT List A	Romanization LDT List B	Romanization LDT List C	Romanization LDT List D	Romanization LDT List A	Romanization LDT List B	Romanization LDT List C	Romanization LDT List D
English Cloze	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**	**English Cloze**
Romanization naming List A	Romanization naming List A	Romanization naming List A	Romanization naming List A	Romanization naming List B	Romanization naming List B	Romanization naming List B	Romanization naming List B
English EIT	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**	**English EIT**

Appendix 8: Mixed effects model estimates for ***Korean romanization*** *production RT data (three-way interaction).*

	Estimate	*t* value
Intercept	6.828	203.861***
Language	-0.301	-12.720***
Switch	-0.047	-6.513***
Proficiency (mean-centered)	-0.005	-1.495
Language x switch	0.167	16.947***
Language x proficiency	0.001	0.299
Switch x proficiency	0.000	0.530
Language x switch x proficiency	-0.000	0.805
Random effects	Variance	*SD*
Participant (Intercept)	0.026	0.163
Participant-language	0.009	0.096
Item (Intercept)	0.008	0.089
Residual	0.029	0.169

Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, . = $p < .10$

*Appendix 9a: Mixed effects model estimates for **Hangeul Korean** comprehension RT data with proficiency and length of residence.*

	Estimate	*t* value
Intercept	6.418	303.590***
Language	0.069	5.513***
Switch	0.080	8.875***
Response type	0.078	8.715***
Proficiency (mean-centered)	-0.003	-1.737 .
Length of residence (mean-centered)	0.001	2.610*
Language x switch	0.001	0.058
Language x response type	-0.012	-0.924
Switch x response type	-0.068	-5.315***
Language x proficiency	-0.002	-2.958**
Language x switch x response type	-0.038	-2.089*
Random effects	Variance	*SD*
Participant (Intercept)	0.018	0.133
Participant-language	0.002	0.047
Item (Intercept)	0.001	0.037
Residual	0.043	0.207

Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, . = $p < .10$

*Appendix 9b: Mixed effects model estimates for **Korean romanization** comprehension RT data with proficiency.*

	Estimate	*t* value
Intercept	6.856	319.723***
Language	-0.353	-15.014***
Switch	-0.021	-1.698 .
Response type	0.022	1.758 .
Proficiency (mean-centered)	-0.004	-1.909 .
Language x switch	0.115	6.865***
Language x response type	0.052	3.096**
Switch x response type	-0.014	-0.815
Language x proficiency	0.000	0.214
Language x switch x response type	-0.019	-0.802
Random effects	Variance	*SD*
Participant (Intercept)	0.009	0.093
Participant-language	0.008	0.090
Item (Intercept)	0.005	0.071
Residual	0.039	0.198

Note. *** = $p < .001$, ** = $p < .01$, * = $p < .05$, . = $p < .10$

Appendix 10: Responses to question regarding Korean romanization (n =26).

Responses	Counts
Yes, I am (very) familiar with it.	8
Yes, somewhat familiar with it.	8
No, not so familiar with it.	6
No, I am not familiar with it at all.	4

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