ABSTRACT

Title of Dissertation:	AN EXAMINATION OF THE INFLUENCE OF AGE ON L2 ACQUISITION OF ENGLISH SOUND-SYMBOLIC PATTERNS
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A number of researchers (DeKeyser, 2012; J. S. Johnson & Newport, 1989; Long, 1990) have argued that age is a critical factor in second language acquisition. This conclusion is based on extensive research over the last two decades that has demonstrated age-related effects in learners' nonnativelike acquisition of phonology, morphosyntax, pragmatics, and discourse-level features of language. In the wake of such findings, there has recently been an increased interest in determining the precise linguistic areas that are difficult for adult learners and the cognitive mechanisms implicated in age-related effects. Because implicit learning plays a key role in first-language (L1) acquisition, particularly in the acquisition of statistical patterns in language, it has been proposed that age effects may be the result of attenuated implicit learning capabilities in late-teen and adult learners (DeKeyser, 2000; Janacsek, Fiser, & Nemeth, 2012). If this is true, age-related effects should be significant in linguistic areas that are not readily amenable to conscious

learning processes and explicit instruction. To determine whether this is in fact the case, this study examined the linguistic knowledge of native speakers (NSs), early L2 learners, and learners who acquired English as adults. In particular, it examined these groups' knowledge related to an area of English that is hypothesized to be difficult to learn explicitly, namely, English sound-symbolic (SS) patterns.

Participants were composed of English NSs ($n = 20$) and three NNS groups with L1 Korean and L2 of English. The NNS groups were divided into three groups based on age of onset (AO)[1], with an AO range from 3 to 9 years of age ($n = 20$), 10 to 16 ($n = 20$), and > 17 ($n = 20$). Three experiments were performed that tested the participants' English magnitude SS sensitivities when forming assumptions about nonce words (Experiment 1 and 2) and their ability to utilize English SS patterns to bootstrap their learning of new vocabulary (Experiment 3). The two late L2 learner groups (AO 10-16; 17+) were found to have significantly reduced levels of SS knowledge compared to the early L2 learners (AO 3-9) and NSs in all experiments. Only in Experiment 1 and 2, the early L2 learners had diminished magnitude SS sensitivities compared to NSs, but not for Experiment 3.

Explicit and implicit aptitudes as measured by LLAMA (Meara, 2005) were also tested for potential relationships with test scores. Explicit aptitudes (LLAMA B, E, and F) did not have a significant effect on the performance of all AO groups, whereas implicit aptitude (LLAMA D) did have a moderate to strong correlation for test scores in only the two late learner groups. The early learner group was not affected by language aptitude levels during the experiments.

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[1] For the purposes of this dissertation, age of onset will be defined as "the age at which learners were first meaningfully exposed to the L2" (Granena & Long, 2013b, p. ix). In other words, the onset implies that the learner has considerable exposure to the L2, comparable in terms of both quality and quantity to the input received by the typical NSs.

In sum, the study has found that there is evidence for SPE in the areas of magnitude and English phonesthemic SS patterns. Implicit language-learning aptitudes appeared to have a facilitative effect on the acquisition of these SS sensitivities for the two late L2 learner groups, but not for the early L2 learners.

AN EXAMINATION OF THE INFLUENCE OF AGE ON L2 ACQUISITION OF
ENGLISH SOUND-SYMBOLIC PATTERNS

By

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Dissertation submitted to the Faculty of the Graduate School of the
University of Maryland, College Park, in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy
2017

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ACKNOWLEDGEMENT

There are many individuals who supported me throughout my doctoral journey. I would like to express my sincere gratitude to all of them.

First and foremost, I am deeply indebted to my advisor, Nan Jiang, for his fundamental role in my doctoral work. He provided me with every bit of guidance, assistance, and expertise I could wish for, despite the difficulties of venturing into the relatively uncharted research area of age effect in the acquisition of sound symbolism. His unwavering confidence in me was the foundation from which my dissertation was built.

I also wish to thank my dissertation committee members for their encouragement and their constructive feedback of the research. I am privileged to have such distinguished scholars in my dissertation committee. I thank both Mike Long and Robert DeKeyser whose courses throughout the PhD program have had substantial influences on my research. I would like to thank Shoko Hamano for her invaluable feedback and her availability in spite of the many demands on her time. I would also like to thank Min Wang for her willingness to take on the role of the dean's representative for my dissertation defense.

Aside from my dissertation committee, I am grateful to Jared Linck, associate research scientist, university of Maryland CASL, for his valuable suggestions and concise comments on the second language aptitude research.

I would like to extend my appreciation to many people who helped me during the intense data collection and preparation for the materials for this study. I give my

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CHAPTER 1: INTRODUCTION

1.1 Overview

A common observation regarding language learning is that children's acquisition

of a first (L1) or even a second language (L2) tends to ultimately result in a level of

linguistic competence characteristic of native speakers (NSs), whereas teen or adult

acquisition of an L2 results in highly variable outcomes and in ultimate attainment (UA)

that is nearly always distinguishable from that of NSs (DeKeyser, 2012; Long, 1990).

The variability in older L2 learners, especially when the older learners attempt to acquire

languages that are typologically distant[2] from their L1, is a widely-observed phenomenon

in adult learners. In Korea, for example, it is common to find native English speakers

who, after arriving in Korea as adults and spending several decades immersed in an

environment where Korean is spoken, can accomplish little more than ordering a meal in

a restaurant. Their meager level of proficiency is often surpassed by more talented

learners who have studied Korean for several weeks. SLA research has sought to explain

this observation by teasing apart the influence of potential explanatory factors such as

instruction, aptitude, motivation, and the quality of input.

Within the field of second language acquisition, there is now broad acceptance of

the view that those who begin their acquisition of a second language at a younger age

generally achieve higher levels of UA than do those who begin later. Such age effects

have been established for a number of key areas of language ranging from accent to

grammatical knowledge. However, there is still considerable controversy regarding the

nature of the age-related decline and the cognitive mechanisms that are implicated. Some

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[2] For a discussion of linguistic distance, see Chiswick and Miller (2004).

researchers (DeKeyser, 2000; J. S. Johnson & Newport, 1989; Long, 2013) have claimed

that there is a "critical" or "sensitive" period, after which there is much greater variability

in outcomes and a marked decrease in levels of UA. Other researchers (Bialystok &

Hakuta, 1999; Chiswick & Miller, 2008) have questioned the existence of a sharp decline

related to a sensitive period (SP). An additional source of controversy has involved the

cognitive mechanisms and processes responsible for age-related declines in UA.

Theoretical accounts range from specifically linguistic accounts, such as those associated

with Universal Grammar (Schachter, 1996; White & Genesse, 1996), to broader

theoretical accounts that argue for a SP based on neurological changes and corresponding

shifts in cognitive functions.

The research outlined in the current dissertation investigates whether SP effects

can be found for an area of language (sound-symbolic patterns) that is believed to be

difficult to acquire through explicit mechanisms. Adult learners' difficulty in this area is

believed to be, at least in part, attributable to a decline in adults' implicit learning

mechanisms, as these mechanisms are believed to underlie sensitivity to probabilistic

patterns within the input (for a discussion of the importance of implicit learning in L1A

and L2A, see (Aslin & Newport, 2012; Ellis, 2002, 2006; Reeder, Newport, & Aslin,

2013).

Sound-symbolic patterns have, in their various guises, been described using a

number of terms, including phonesthemes, onomatopoeia, and mimetics. This area of

linguistic competence, which to the best of my knowledge has not been examined yet in

research on the SPH, is ideally suited to the current investigation due to its statistical

nature. These patterns, unlike many lexical or grammatical patterns, are not associated

with consistent form-meaning mappings. Their acquisition would require learners'
sensitivity to subtle statistical biases in the input, according to which specific
phonological features or segments tend to be associated with certain abstract semantic
features (e.g., magnitude or iteration) at rates greater than would be expected by chance.

The dissertation will discuss: (1) the SPH and the attenuation of implicit learning
mechanisms as an explanation for the SP, (2) the choice of sound symbolism as an area
of language ideally suited to determine learners' ability to acquire form-meaning patterns
implicitly, and (3) experiments to determine whether SP effects occur in this area. The
review of the SPH literature will discuss: (1) sensitive periods in nonlinguistic domains,
(2) the historical background of the SP debate related to language, (3) definitions of key
terms, (4) evidence for SPs in L1 acquisition, (5) evidence for SPs in various areas of L2
linguistic competence, such as phonology, semantics, morphosyntax, pragmatics, and
discourse-level features, (6) other evidence for the SP, such as global proficiency ratings,
neurological measures, processing differences, and differences in the learning
mechanisms associated with early and late language acquisition, (7) counter-arguments
against the SPH and other factors to be considered, (8) the influence of L1 and L2
interactions, (9) possible mechanisms underlying the SP with a focus on implicit learning,
and (10) the role of language aptitude.

The section on SS will discuss: (1) the history of the discussion of iconicity in
language, (2) definitions of terms, (3) universal tendencies in sound symbolism, (4)
language-specific tendencies, focusing on Korean and English, (5) reasons for the
emergence of sound symbolism in language, (6) verification of the existence of sound
symbolism based on statistical biases in form-meaning mapping within a specific

language, (7) verification of the psychological reality of sound symbolism, (8) first language acquisition (L1A) of sound symbolism, and (9) early and late L2 acquisition (L2A) of sound symbolism.

This will be followed by the overview of the current study. Three experiments will then be described. The final section will discuss the potential contribution of the study to our current understanding of the SP with a focus on the attenuation of implicit learning mechanisms used for statistical learning in teens and adults.

Before discussing the SPH in terms of humans, it should be noted that critical periods (CPs) are well established for a number of abilities within nonhuman species. For example, it has been shown that birds have a CP for the acquisition of bird song (Doupe & Kuhl, 1999) and that there is a CP for multimodal spatial mapping in owls (Knudsen, 1998). There is also a CP during the second month of life for the development of vision in cats (Hubel & Wiesel, 1970).

1.2 Nonlinguistic and Linguistic SPs

Turning to humans, sensitive periods (SPs) appear to exist for a number of complex skills. For example, the ability to identify absolute pitch also appears to be nearly impossible to develop after childhood. A survey of over 600 musicians found that 40% of those who had begun training before age 4 had this ability compared with only 4% of those who began between the ages of 9 and 12 and 2.7% of those who began training after 12 (Baharloo, Johnson, Service, Gitschier, & Frieimer, 1998). Awareness of absolute pitch may have direct relevance to the acquisition of language, specifically tonal languages such as Chinese and Vietnamese (Deutsch, Henthorn, & Dolson, 2004).

Within the field of second language acquisition (SLA), there has been considerable debate regarding the existence of a SP for the learning of a language. One difficulty in the discussion is in reaching a consensus regarding terminology. SLA researchers generally agree that the concept of a SP must be clearly distinguished from the issue of rate of learning. In other words, arguments for an SP do not entail the idea that "younger is always better." In fact, one early review (Krashen, Long, & Scarcella, 1979) of the relationship between age, learning rate, and UA essentially concluded that L2A was characterized by a tortoise-and-hare scenario: older learners enjoy an advantage in rate of morphological and syntactic attainment and pass through the relevant linguistic stages more quickly, but are eventually surpassed by younger learners. DeKeyser (2003) attributes older learners' short-term advantage to their enhanced ability to take advantage of explicit learning mechanisms.

One of the earliest arguments for a sensitive period for language acquisition was put forth by Lenneberg (1969), who argued that behavioral evidence for a sensitive period corresponded with maturational changes related to hemispheric lateralization in the brain. He noted that young children, whose brains were not yet lateralized in terms of functions, could much more easily recover from brain aphasia resulting from brain trauma. His maturational view of acquisition was based on the idea that biological development led children to be sensitive to successively different aspects of their environment.

> The child first reacts to intonation patterns. With continued exposure to these
> patterns as they occur in a given language, mechanisms develop that allow him to
> process the patterns, and in most instances to reproduce them (although the latter

is not a necessary condition for further development). This changes him so that he

reaches a new state, a new potential for language development. Now he becomes

aware of certain articulatory aspects, can process them and possibly also

reproduce them, and so on. A similar sequence of acceptance, synthesis, and state

of new acceptance can be demonstrated on the level of semantics and syntax (p.

641).

1.3 Definition of the Sensitive Period Effect

DeKeyser and Larson-Hall (2005) define the sensitive period hypothesis (which

they, following established convention in SLA, refer to as the "critical period hypothesis")

as the idea that "language acquisition from mere exposure (i.e., implicit learning), the

only mechanism available to the young child, is severely limited in older adolescents and

adults," and they note that the hypothesis applies to both L1A and L2A (p. 89). Early

L2A is, for all intents and purposes, thought to draw on similar mechanisms as early (i.e.,

typical) L1A. Along similar lines, Abrahamsson and Hyltenstam (2008) stipulate that the

SPH would be falsified if a post-SP NNS were found who lacked high aptitude and had

not worked professionally with the TL still managed to attain nativelike levels of

proficiency.

One criticism of the use of the term "critical period" is that an SP implies a

species-wide characteristic which should transcend individual differences (Muñoz &

Singleton, 2011). Many researchers have therefore sought to replace the term critical

period with sensitive period. Notably, there has been a recent consensus that the term

"sensitive period" is a more realistic definition of the phenomena, as learners tend to

experience more variability in timing and end-product after the offset. This contrasts with the term "critical period", which seems add more emphasis on the idea of an inevitable deterioration and dramatic decline of the human ability to learn language.

As noted above, the "sensitive period" terminology puts more stress on an optimal window for language learning that can be wider or more narrow depending on the language area, in addition to more variability in patterns of decline[3] (DeKeyser & larson-Hall, 200r; Long, 2013).

The current study outlines three critical qualities that distinguish SPE from just any age-related language learning decline:

(a) a younger group, perhaps in infancy or childhood depending on the language area, that ultimately achieves native or near native proficiency,

(b) an age range following the younger group where there is a gradual decline in the tendency to achieve a near-native UA for learners, often condensed in the late childhood, pre-adolescent, or adolescent age range,

(c) and a final group following the decline that rarely achieves near native proficiency in the language area. This older NNSs will *not* continue to decline in level of UA outcomes, so the beginning of this group is referred to as a point of discontinuity. It will be noted that the ability to acquire an L2 continues to decline (albeit, more gradually) after the offset due to the general decline in various cognitive abilities due to aging, and partly due to additional variables such as amount of

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[3] Research suggests that patterns of maturational declines differ across language domains. NNSs have higher tendencies of native-like UA in pronunciation, morphology, and syntax if they have AOs from 0 to 6 years. The closure of the offset period closes around the AO of 12 for pronunciation, and around 15 for morphology and syntax.

exposure, often measured by length of residence (LOR), and the proportion of L1 and L2 use.

It will be further stipulated that this divergence should not occur solely due to differences in quality or quantity of linguistic input or social interaction. Furthermore, this divergence can take the form of deficits and reduced sensitivity to specific target language (TL) features, or the reduced ability to use these features in comprehension, production, or ongoing acquisition of the TL. In other words, those who begin to learn an L2 after the SP may have a reduced ability to extract complex patterns (e.g., probabilistic patterns) from the input and may therefore lack certain implicit knowledge about the TL (e.g., the association of the English cluster *gl-* with meanings related to vision and light). This lack of implicit knowledge would presumably hinder their ability to reach levels of ultimate attainment (in at least some areas of linguistic competence) on par with that of NSs.

Finally, it should be noted that the concept of a SP must be untangled from questions regarding a speaker's stronger language. While it appears that language dominance is largely determined by age of acquisition (Jia & Aaronson, 2003), there are also instances in which the L1 undergoes attrition and the L2 becomes a speaker's dominant (and perhaps, only) language (Pallier et al., 2003; Ventureyra, Pallier, & Yoo, 2004). However, L1 attrition, which is concerned with loss of language abilities, has no direct bearing on the validity of the SPH, which concerns the ability to acquire language. In other words, even if a given speaker's L2 proficiency surpasses her or his L1 proficiency at some point after the end of the purported SP, this should not be used as evidence against the SPH.

1.4 Evidence for SPs in L1A and L2A

1.4.1 Feral Children, Late Deaf L1A and the SPH

The obvious experimental test to determine whether maturational constraints of the sort proposed by Lenneberg actually exist would be to deprive a child of the necessary linguistic input until after the end of the purported SP, but such an experiment is out of the question due to ethical concerns. However, there have been reports of children who, due to child abuse or other reasons, were not exposed to continuous linguistic input during childhood. These children, often called "wild" or "feral" children, have generally failed to develop more than rudimentary linguistic abilities.

One early and relatively well-documented report of such a "feral child" was the case of Victor of Aveyron, who was taken into care in the year 1800 (Lane, 1976; Shattuck, 1980). Although inquisitive and seemingly intelligent, Victor is said to have acquired virtually no language abilities by the time of his death in 1828. Dozens of other cases can be found in the literature (Benzaquen, 2006), and in almost all cases, the children are said to have failed to develop nativelike language. A better-documented recent case involves the child known as Genie who was raised with virtually no social or linguistic interaction from the age of 20 months to 13 years and seven months as a result of child abuse (Curtiss, 1981; Fromkin, Krashen, Curtiss, Rigler, & Rigler, 1974). In spite of intensive training by linguists and teachers and despite socialization within various foster homes, Genie ultimately developed only a meager spoken vocabulary, using syntax that was clearly nonnative. Her acquisition of sign language was slightly more successful but still fell far short of native levels.

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Cases of feral children provide a tantalizing glimpse into the effects of late L2A, but they must be viewed as poor grounds for rejecting or accepting the SPH. Reports of wild children often claim that children are alone in the wild from infancy, but this is highly unlikely in light of the fact that even adults with wilderness skills often fail to survive alone in the wild without a network of social support (Kroeber & Kroeber, 2002). Some children have wandered away from abusive homes when fairly young, but such children probably have had some language acquisition. For this reason, the literature on feral children and the observation of such children's inability to learn language, instead of providing evidence for a SP, provide more compelling evidence regarding the issue of L1 attrition, although even here, the evidence must be interpreted with extreme caution. Even modern cases such as that of Genie are difficult to interpret, since neglect is known to result in long-term general cognitive deficits (Chugani et al., 2001; Uylings, 2006).

A better source of evidence for a SP for L1A comes from data on deaf learners who were first exposed to language after childhood. Grimshaw, Adelstein, Bryden, and MacKinnon (1998), for example, report on the case of a young man who had been born deaf but was not exposed to sign language at a young age. He was fitted with hearing aids when 15 and thereafter began to acquire Spanish. Observing the man's competence after four years of acquisition, the authors concluded that he showed severe deficits in both comprehension and production, results that are congruent with the SPH.

There are also a number of studies of deaf learners who first acquired sign language at some point between birth and adulthood. The late acquisition of language in such cases reflects failure to recognize hearing loss early in life or the lack of educational

awareness or resources within some communities. Some of these studies have been listed in Table 1.

As can be seen, first language acquisition after childhood consistently results in noticeable reductions in grammatical competence, particularly when it is measured using online tasks. Moreover, the behavioral observations are accompanied by changes in tissue concentrations in the brain (Pénicaud et al., 2012). The results are thus consistent with the view that there is a sensitive period in late childhood for the acquisition of an L1.

The results suggest that late L1 learners acquire their first language as if it were an L2. In fact, the deficits exhibited by late deaf learners as well as feral children appear to be even more severe. In support of this, Mayberry (1993) has shown that participants who acquired ASL *as an L2* after childhood outperformed those who acquired it as an L1 at the same age. These results could be interpreted as an "exercise" effect, according to which the innate ability to learn language undergoes less attrition if it is used. It could also be that these learners are able to transfer elements of their L1 to their L2.

Table 1.

Research on Late L1A of Sign Language

Study	Participants	N	Measure	Findings
Boudreault & Mayberry (2006)	Deaf learners acquiring sign between birth and age 13	30	Grammatical judgment task (GJT)	Increased age of onset (AO) was correlated with reduced grammatical knowledge.
Cormier, Schembri, Vinson, & Orfanidou (2012)	Native, early (2-8), and late (9-18) deaf learners of sign	20	GJT	Accuracy of grammaticality judgment decreases as AO increases, until around age 8. (Results for older learners were hard to interpret due to presence of learners with English as an L1).
Emmorey, Bellugi, Friederici, & Horn (1995)	Exp. 1: Native and late signers (M AoA = 12) Exp. 2: Native, early	Exp. 1 = 21	Video sign monitoring task	Exp. 1: Only natives were sensitive to verb agreement violations. Exp. 2: Natives were sensitive to both verb

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Study	Participants	N	Method	Findings
	(AoA = 2-7), and late (AoA = 10 – 20) signers	Exp. 2 = 30	Sign monitory task, GJT	agreement and aspect; early learners were sensitive to aspect morphology. In the GJT, all groups could detect errors.
Mayberry (1993)	Learners born deaf with varying AoAs, English speakers who became deaf	36	Sentence recall	Participants who acquired ASL as an L1 declined in association with increasing AOs, with effects most apparent for sentence processing skills, grammatical acceptability, and memory for sentence meaning.
Mayberry & Eichen (1991)	Deaf learners acquiring sign between birth and age 13	49	Sentence memory paradigm	Errors increased with AO.
Mayberry & Lock, 2003)	NS normal hearing controls, early AO signers, early normal hearing early L2 learners, late learners of sign	54	GJT, sentence to picture matching	Late learners of sign performed poorly.
Pénicaud et al. (2012)	Infant signers (AO < 3), early signers (AO = 4-7), late signers (AO = 11-14)	24	Voxel-based morphometry	Delayed L1A was associated with changes in brain tissue concentration in occipital cortex.

1.4.2 L2A of Phonology and the SPH

In addition to the research discussed thus far that has examined an SP for L1A, a larger body of research has accumulated, mostly conducted during the last two decades, on sensitive period effects for L2A. In the literature review presented here, the initial discussion will focus on studies related to phonology. These studies have been summarized in Table 2.

Table 2.

Research on Sensitive Period Effects for L2A of Phonology

Study	L1	L2	*N*	LoR Range	AoA Range	AoA and L2A's *r*	Method	Findings
Abraham-sson (2012)	Sp. Swd.	Swd. N/A	200 20	15-46	1-30		VOT percept., GJT	Both early AoA (1-15) and late AoA (16-30) groups differed from NSs. Only 9% of those with AoA 11-15 performed in NS

								range on all measures.
Asher & Garcia (1969)	Sp. Eng.	Eng. N/A	71 30	1-8	1-19	not stated	Accent ratings	Participants judged to have near-native accents fell from 41% in the 7-12 AoA group to 7% in the 13-19 AoA group.
Aoyama, Flege, Guion, Akahane-Yamada, Yamada (2003)	Jpn. Jpn. Eng. Eng.	Eng. Eng. N/A N/A	16 16 16 16	*M*=1.6 *M*=1.6 N/A N/A	6-13 adults children adults		Accent ratings	Only children improved after a year of residence in U.S.
Flege, Birdsong, Bialystok, Mack, Sung, Tsukada, (2006)	Kor.	Eng.		3-5			Accent ratings	NNS children outperformed adults but still had a detectable accent after average of 4 years.
Flege & MacKay (2004)	Ital.	Eng.					Vowel percept.	Those who used their L1 more had stronger accents.
Flege, MacKay, & Meador (1999)	Ital.	Eng.					Vowel percept. & product.	Early, unlike late, L2 learners successfully create new categories for L2 vowels. Production and perception abilities are closely related.
Flege, Munro, & MacKay (1995)	Ital.	Eng.	240	15-44	2-23	not stated	Accent ratings	AoA accounted for 60% of variance. Participants with AoA > 16 were all nonnativelike.
Flege, Yeni-Komshian, & Liu (1999)	Kor.	Eng.	240	*M*=15	1-23		Accent ratings	Increases in AoA were associated with stronger accents.
Hojen & Flege (2006)							Vowel percept.	Early AoA learners were similar but not identical to NSs in their sensitivity to vowel contrasts.
Huang & Jun (2011)	Ch. Eng.	Eng. N/A	30 10				Read-aloud task	AoA impacted different aspects of prosody in different ways. The effect was present even after effects of other variables were controlled.
Ioup & Tansom-boon (1987)	Thai Eng. Eng. Eng.	Thai Thai Thai Thai	2 2 2 2					Tone was acquired very early by children learning Thai as an L1 or L2, but even advanced adult learners exhibited difficulty acquiring tones.
MacKay, Meador, & Flege (2001)	Ital.	Eng.					Consonant percept.	AoA *M* = 7 made fewer errors identifying initial English consonants in noise than AoA *M* =19 group. Greater L1 use as well as phonological short-term

								memory was associated with reduced ability. Late AoA ($M = 20$) group had greater difficulty differentiating short-lag /b d g/ tokens from /p t k/ than did their early AoA counterparts.
Munro & Mann (2005)	Ch.	Eng.					Accent ratings	AoA related increase in degree of accent was linear. Females were rated as more native and showed greater variation.
Tahta, Wood, & Loewenthal (1981b)	Misc.	Eng.	109	< 1	< 5	.66	Accent ratings	If AoA was 6 or below, participants had no accent. If it was between 7 and 11, there was generally a very slight accent. After AoA of 13, there was invariably an accent. Greater L1 use at home also led to stronger L2 accents.
Oyama (1976)	Ital.	Eng.	60	5-20	6-20	.69 stories .83 para- graphs	Accent ratings	AoA > 12 associated with nonnativelike attainment. Accent begins appears with even younger AoAs.
Thompson (1991)	Rus.	Eng.	36				Accent ratings	Those with AoA 4-10 had a slight accent. L1 maintenance was associated with L2 accent.
Yeni-Komshian, Robbins, & Flege (2001)	Kor.	Eng.	192	< 7	6-23	.31 conso- nants .69 vowels	Deviations from NS norms	Late L2 learners (AoA 12-23) were more accurate in pronunciation of, and detection of errors in, verbs. AoA 10-11 appears to be cut-off, before which L2 pronunciation is better and after which L1 pronunciation is better.

In terms of accent, the studies in Table 2 generally show that L2 acquisition beginning during the teen years or later is nearly always associated with at least a slight nonnative accent. Moreover, many studies report nonnative acquisition for a sizable portion of the participants who begin L2A between 8 and 10.

It has been noted in numerous studies that early or simultaneous bilinguals develop language systems that are distinct in some ways from systems of monolingual speakers of both languages (Hyltenstam & Abrahamsson, 2000). Some findings suggest that the languages of the bilingual interact. One interesting finding is that L1 maintenance

is shown in many studies to hinder the development of nativelike L2 accent in younger

learners (Flege, Frieda, & Nozawa, 1997; MacKay, Flege, & Imai, 2006; Moyer, 2011).[4]

A number of models of bilingual phonological acquisition (Best, 1994; Flege, 1995; Kuhl,

1992) suggest that bilingual learners construct interlanguage phonologies in which

phonological representations are ideally suited for the bilingual system and, as a result,

fail to conform to the representations of monolinguals of either language. Such findings

in phonology and other linguistic domains have led to the view that NNSs' divergence

from NNS norms can, to some extent, be viewed as an inevitable outcome of bilingualism

itself (Birdsong, 2005; Cook, 1991). Yet it should also be noted that bilinguals who are

balanced bilinguals from birth are generally found to undergo similar developmental

paths and exhibit similar linguistic abilities as monolinguals who speak the same TLs (De

Houwer, 2002).

The L2A literature generally agrees with the view that the ability to recognize

new phonemes and develop representations that are not overly influenced by those of an

L1 is rapidly

lost in adolescence. This would explain older children's loss of the ability to accurately

mimic intonation patterns. This ability, which children typically lose between the ages of

8 and 11 (Tahta, Wood, & Loewenthal, 1981a), is rare in the adult population, although

some exceptionally talented language learners may preserve it (Bongaerts, Planken, &

Schils, 1995; Bongaerts, Van Summeren, Planken, & Schils, 1997; Schneiderman &

Desmarais, 1988). Many of these learners have achieved a high enough proficiency level

to appear nativelike, but upon closer examination very few learners score within native

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[4] For a study claiming that L1 maintenance is not associated with a negative effect on L2A, see Bylund, Abrahamsson, and Hyltenstam (2012).

norms. Abrahamsson and Hyltenstam (2009) tested highly proficient Swedish L2

speakers ($N = 195$) on a battery of 10 cognitively demanding linguistic tasks. A little over

20% of the NNSs were found to be nativelike, and none of the late learners (AO $\geq$ 12)

could perform within native speaker norms on all tests. For late learners the highest score

was from a woman who exhibited scores in the native range for all tests except for

phonetic aspects of speech production and perception. Surprisingly, only a minority of

the early learners reached nativelike competence across the cognitively demanding

battery of test, suggesting that incidence of L2 nativelikeness may be less common than

previously estimated.

　　In addition to AoA (Age of Acquisition), some other factors have been shown to

be associated with accent and phonological sensitivity. For example, female learners

appear to enjoy a slight advantage over their male counterparts, which enables them to

attain more nativelike outcomes at older AoAs. Even so, AoA appears to be the most

reliable predictor of the degree of foreign accent (Piske, MacKay, & Flege, 2001). There

remains considerable debate over whether the decline in phonological abilities is gradual

over the lifespan. However, the study gives evidence that the correlations between AoA

and degree of foreign accent appear to be non-linear and suggestive of a discontinuity

between the younger and older learners. This led the researchers to propose the results

"do not disprove of a critical or sensitive period for L2 speech learning."

1.4.3 L2A of Morphosyntax and the SPH

　　In addition to phonology, many studies have examined SP effects in the area of

morphosyntax. One groundbreaking study in this area was conducted by Coppieters

(1987, as quoted in Birdsong, 1992) who interviewed highly-advanced speakers of French, asking them about their intuitions regarding a number of difficult grammatical contrasts. He found that no NNSs in his study performed within NS range. In one of the most cited studies, J. S. Johnson and Newport (1989) examined 46 native Korean or Chinese speakers who had an AoA between 3 and 36. Participants' performance on a GJT showed a strong effect for AoA until puberty, after which performance was lower and much more variable. DeKeyser (2000) conducted a similar study that examined the performance of 57 Hungarian adults with AoAs ranging from 1 to 40 and LORs of at least ten years. He found high negative correlations between AoA and GJT scores and virtually no overlap between the scores of those who arrived before and after the age of 16. All but one of the older participants who scored within the range of childhood learners had high verbal aptitude scores (Granena, 2012; Harley & Hart, 1997).

Some researchers have suggested that SP effects are primarily related to processing difficulties and do not represent actual deficits in underlying competence (Hopp, 2006, 2010; McDonald, 2006). Several studies have demonstrated that advanced learners, including learners who demonstrate knowledge of a target L2 structure in an offline task, fail to exhibit sensitivity to the same structure in online tasks. Jiang (2004), for example, employed a self-paced reading task to determine whether Chinese learners of English exhibited sensitivity to number disagreement in English sentences. Although the participants showed sensitivity to other linguistic idiosyncrasies, they failed to show the significant increases in reaction times (RTs) associated with sensitivity to number. The results were interpreted as showing that older learners may fail to develop nativelike grammatical contrasts if these same contrasts are lacking in their L1 (Jiang, 2007; Jiang,

Novokshanova, Masuda, & Wang, 2011). Mueller and Jiang (2013), using a self-pace

reading task, have similarly shown that advanced English-L1 learners of Korean lacked

sensitivity to the Korean honorific suffix *–(u)si*. These studies suggest that online tasks

that prevent participants from consciously reflecting on language may be more

appropriate when testing for SP effects.

1.4.4 L2A of Semantics and the SPH

Several studies have found evidence for SPE in the language area of semantics.

For example, Granena and Long (2013a) tested the lexis and collocational sensitivities of

Chinese learners of Spanish of varying AOs (AO 3-6; 7-15; 16-29). A strong, negative

relationship between AO and test performance was found in the early adolescent group

(AO 7-15), followed by a discontinuity characteristic of an SP. Similarly, Spadaro (2013)

investigated the word-association, oral production, and written lexical abilities of highly

proficient NNS of English. The late learner groups (AO 7-12; 13+) demonstrated

similarly reduced levels of L2 lexical knowledge on the tasks, suggesting an SP for

lexical acquisition roughly around the AO of 6. Munnich and Landau (2010) analyzed

maturational declines in spatial semantic learning mechanisms. The participants were

adult learners with an L1 of either Spanish or Korean separated into groups based on age

of immersion in the English L2. Interestingly, both the Spanish and Korean NNS groups

performed similarly in the experiments, suggesting that the participants' L1 did not affect

their receptivity to spatial semantic input. On the other hand, McDonough, Choi, and

Mandler (2003) found that L1 could potentially impact the NNSs' ability to encode

spatial relations of tight containment vs. loose support. Infants were found to be capable

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of categorizing both spatial contrasts, whereas adults with an L1 of either English or

Korean demonstrated difficulty in terms of sensitivies to L2 spatial relations that were

not present in their mother tongue.

1.5 Arguments against the SPH

A number of studies have questioned the existence of a clearly delineated SPs.

Some of the most influential of these studies have been based on data from the U.S.

Census (Bialystok & Hakuta, 1999; Chiswick & Miller, 2008; Stevens, 1999, 2004).

While a discussion of this research is beyond the scope of the dissertation, the basic

position taken in this literature review is that the data in these studies are much too coarse

and that they therefore have no bearing on the SPH (DeKeyser, 2006; Long, 2005;2007).

Another group of studies challenging the SPH deal with highly accomplished

adult L2 learners. A number of research conducted by Bongaerts and colleagues

(Bongaerts, 1999; Bongaerts, Mennen, & Van der Slik, 2000). Bongaerts et al. (1997)

found that some Dutch learners of English could not be distinguished from NSs. They

attributed the rather exceptional performance of these learners to the facilitative effects of

variables such as motivation and the use of phonological perceptual training. In a sense,

such training weakens the usefulness of these learners as potential counter-examples to

the SPH since young children clearly do not need such training to attain native-like

pronunciation.

Another impressive example of highly accomplished learners comes from a study

by Ioup, Boustagui, El Tigi, and Moselle (1994). The two learners, "Julie" and "Laura,"

are described as having achieved near-native acquisition of Egyptian Arabic. Yet even

these learners diverged noticeably from NSs on at least one component of the battery of measures. It should also be noted that "Julie," who was described by the authors as the more naturalistic learner, made a highly conscious and reflective study of the language, methodically keeping track of language patterns in a journal and asking NSs about proper usage. Her acquisition would therefore appear to be based on hypothesis testing and the noticing of key features in the input (for a discussion of the importance of noticing and explicit processes in adult SLA, see DeKeyser, 2003; Schmidt, 1990, 2001).

Initially, highly proficient L2 learners like Julie would appear to weaken the scope of the CPH, as the minority of adults who appear to be "immune" to developmental declines. However, a more plausible interpretation would be that Julie spent a great deal of time and effort on the explicit learning of languages. This would explain why the researcher found her not to be near-native in every tested language area. Another potential factor could be that Julie had above average language-learning abilities that would, notably, *not* render her equivalent to a younger learner, but rather define her as a highly talented adult learner who took full conscious advantage of the potential.

Schneiderman and Desmarais (1988) have claimed that there is a neuropsychological substrate, based on greater cognitive flexibility, associated with such talent. They point out that this enhanced "flexibility" is distinct from the plasticity in children's brains which enables them to compensate for loss of functions due to brain damage. Talented learners, in addition to achieving high ultimate attainment, are also said to learn much more quickly, often mastering the basics of a language within weeks. These cognitive abilities, which are quite rare, apparently allow some adult learners to avoid processing an L2 using entrenched cognitive patterns associated with their L1. The

authors suggest that this talent can probably be separated into a talent for phonology and a talent for morphosyntax.

1.6 Potential Explanatory Mechanisms Underlying Linguistic SPs

If it is accepted that a SP exists, it is important to identify its basis. Many researchers have sought to explain the SP in terms of brain maturation (Lenneberg, 1967; Penfield & Roberts, 1959; Pulvermüller & Schumann, 1994; Uylings, 2006). Chugani (1998), for example, has explained it in terms of (1) synaptogenesis, (2) the high glucose utilization window, and (3) pruning as a mechanism underlying advantages for much early learning. Such explanations have the advantage of broadly applying to other complex skills that are also learned better by children.

Another tantalizing idea, referred to as the "less is more" hypothesis, is that children actually benefit from lower working memory abilities (DeCaro, Thomas, & Beilock, 2008; Newport, 1990, 1991). The plausibility of the hypothesis has been demonstrated using mathematical and connectionist modeling (Elman, 1993; Fielder & Kareev, 2011; Goldowski & Newport, 1993; Kareev, 1995, 2000).[5] Monner, Vatz, Morini, Hwang, and DeKeyser (2013) applied neural network model to better understand the independent effects of L1 entrenchment and memory development of L2 performance declines. The results suggested that AO does have a negative relationship with ultimate L2 proficiency when the potential confounds of variable interaction was controlled for, implicating adverse L1 entrenchment effects and supporting the less-is-more hypothesis. Some experimental studies have also provided support (e.g., Kersten & Earles, 2001).

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[5] For counter-evidence, see Rohde and Plaut (1999).

Cochran, McDonald, and Parault (1999), for example, found that adults practicing sign language learned better under cognitive load conditions. [6]

Other researchers have claimed that successful learning of a complex skill or knowledge set inevitably results in a paradox, in that it is difficult to radically alter the system when encountering new inputs (e.g., when learning an L2 as an adult). Seidenberg and Zevin (2006), for example, discuss connectionist modeling that suggests that as connectionist networks develop successfully, they become entrenched, making it difficult to acquire new patterns that generalize widely to novel instances. Unlike the "less is more" hypothesis, this view is not based on biological maturation. Difficulty in reorganizing certain knowledge networks is viewed as solely due to the fact that the areas of knowledge associated with sensitive periods are almost always acquired early in life.

This view has difficulty explaining the observed trouble experienced by late L1 learners (e.g., older deaf learners of sign language). Seidenberg and Zevin (2006) suggest that the informal gestures used by caregivers in the years prior to exposure to sign language are actually learned as a system (i.e., they essentially constitute the deaf learners' L1) and that this entrenched learning interferes with subsequent learning of sign language. This explanation seems implausible as such gestures are largely iconic and unsystematic. This being the case, it seems unlikely that they would compete with something as dissimilar as sign language, which represents fully developed linguistic systems.

The entrenchment view also has difficulty explaining why adults often fail to attain the highest levels of proficiency in other complex skills (e.g., the violin or chess)

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[6] One possible counter-argument, mentioned by DeKeyser and Larson-Hall (2005), is that children, instead of consistently parsing input in small increments, have been shown to use chunk learning of collocations and formulas at a young age (for a discussion of children's use of collocations in L1A and L2A, see Peters, 1983; Wong Fillmore, 1976; Wray, 2002).

when these skills or knowledge systems are acquired after childhood. This is problematic. Connectionism, after all, is, by its very nature, a theory of general cognition and is not limited to language, so it is not clear why it should have even less explanatory force when applied to nonlinguistic areas. The discussion thus far should not be construed as dismissing connectionist views on cognition or related ideas on cognitive entrenchment. The objections merely suggest that these specific entrenchment-related explanations are inadequate, when taken by themselves, to explain SP effects.[7]

Researchers have also sought to explain the SP in terms of access (or the lack thereof) to Universal Grammar (L. Rothman, 2008; White, 2003; White & Genesse, 1996). These theories, which say nothing regarding general cognitive mechanisms and the existence of sensitive periods for a wide range of nonlinguistic learning, have less explanatory power. Moreover, there are elements of language outside of UG that appear to be problematic for adult L2 learners ((Birdsong, 1992; J. S. Johnson & Newport, 1991). If this is the case, then UG, even if it is considered part of the explanation, cannot possibly provide a fully adequate explanation. The current study will adopt the position that the existence of sensitive periods for both language and many other complex skills are likely to have a single explanation: UG-based explanations will therefore not be considered.

When considering a SP, some researchers have asked, what evolutionary advantages would a sensitive period provide? Why would it not be more advantageous to evolve a brain that can learn a language or other complex skills at any age? Hurford (1991) has considered this question in terms of an evolutionary model, which he has

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[7] One possible answer could come from the apparent trade-off between highly acute implicit learning abilities and established skills that are fully acquired and automatic. It could be that ongoing cognitive flexibility is simply incompatible with the rapid deployment of learned responses to the environment.

simulated on a computer. He has shown that a SP that ends around puberty is in fact

optimal in regards to selective advantages. He argues that instead of searching for

advantages for adults' relative inability, we should search for the age during which the

need for heightened ability is likely to exert the greatest pressure on organisms to

undergo evolutionary changes.

1.7 Attenuation of Implicit Learning Capabilities in Adults as an Explanation for the SPE

NSs display knowledge of many subtleties of their L1 about which they lack

conscious knowledge. Many of these subtleties involve probabilistic regularities of the L1.

To cite just one example, NSs' sentence processing has been shown to be sensitive to

verb subcategorization biases, for example, the tendency of a verb to be accompanied by

a direct object or clausal complement or to occur in an active or passive frame (see, for

example, Gahl, Jurafsky, & Roland, 2004).

Because probabilistic regularities require the gradual tallying of distributional

features within massive quantities of input, they are generally thought to be learned

implicitly. In this dissertation, implicit learning will be defined, as in DeKeyser (2003),

as "learning without awareness of what is learned" (p. 314). As DeKeyser mentions, this

form of learning is orthogonal to both inductive learning and implicit memory. The

general psychological literature has confirmed implicit learning using a number of

paradigms to include artificial grammar learning, sequence learning, and control of

complex systems. The common feature in these methodologies is the use of patterns that

are (1) difficult to notice due to their complexity and/or the task instructions and (2) even

if noticed, difficult to learn consciously due to their complexity.

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Implicit learning is important in explaining children's acquisition of their L1. Research (e.g., Saffran, Aslin, & Newport, 1996; Teinonen, Fellman, Naatanen, Alku, & Huotilainen, 2009) has shown that implicit learning mechanisms are available very early in infancy. Explicit learning mechanisms are also available fairly early; however, it must be noted that these early explicit systems, which tend to enlist the support of verbal mediation, are thought to be less developed in children than in adults (Bauer, Burch, & Kleinknecht, 2002). Implicit learning is particularly important in accounting for children's sensitivity to frequencies in the input. Extensive research has demonstrated that statistical regularities enable children to learn formal generalizations in a number of areas, to include phonological patterns such as principles of word segmentation (Pelucchi, Hay, & Saffran, 2009; Saffran et al., 1996) and phonotactics constraints (Chambers, Onishi, & Fisher, 2003) as well as syntactic patterns such as predictive cues to phrase structure (Saffran, 2001).

Adults are also able to learn implicitly. Ellis (2006), summarizing previous research on the topic, claims that implicit learning occurs as a result of the frequency of the target association (e.g., the association between a linguistic pattern and its meaning) along with tracking of its recency (recent associations are more salient) and contextual cues. Target associations go beyond transitional probabilities to include more detailed knowledge, such as mutual information (Krogh, Vlach, & Johnson, 2012). In language learning, implicit learning is constrained, to some extent, by the distance between elements. Adjacent elements are learned more easily, while non-adjacent elements, if they occur, tend to be separated by elements of a different type, as when consonants are separated by vowels (Newport & Aslin, 2004). For example, the repeated vowel /i/ that

denotes smallness in English SS is readily detected in the sound-symbolic word *eensy-weensy* (i.e., baby talk for "very tiny") since the other sounds in the word are consonants and are therefore of a different type.

Some factors may conspire to limit the adults' capacities for implicit L2A. First, as Ellis mentions, cues may be unreliable predictors. For example, a phonological pattern (e.g., the phoneme /a/) may have only limited value in predicting associated patterns of meaning (e.g., large size). Second, the L2 learner may be affected by entrenched L1 patterns. This can result in transfer involving individual patterns, but at a more subtle level, it can constrain the learner's use of cues when processing linguistic input (MacWhinney, 1997) and may also influence the learner's attention toward features of the environment that require linguistic encoding during production (Slobin, 1996). To some extent, these limitations can be overcome through instructional interventions designed to draw attention to subtle cues. Ideally, these interventions would reset the learner's use of cues[8] and result in associations that were fully integrated and automatic features of the L2 learner's language. Examples of such interventions would include Focus on Form (Long, 1991) or Input Processing (VanPatten, 1996). Yet even these focused interventions may have only a limited effect on the most difficult areas of language (for a discussion of factors related to difficulty, see DeKeyser, 2005). In short, some aspects of an L2 appear to be difficult to acquire through explicit learning and by adults' attenuated implicit learning.

The role of implicit mechanisms has figured prominently in the debate over the SPH. For example, DeKeyser (2000) has attributed SPH findings to a marked decline in

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[8] For a description of how certain interventions may subtly alter L2 learners' psycholinguistic processes, see Doughty (2001).

the "ability to induce abstract patterns implicitly" resulting from the "inevitable consequence of fairly general aspects of neurological maturation" (pp. 518, 519). As a result, he believes that adults are largely limited to explicit learning (see also Howard et al., 2004; Ullman, 2001).

Corroboration of this conclusion was provided by Janacsek et al. (2012). They have shown that implicit skill learning declines in a nonlinear manner across the lifespan. In their study, participants ranging from 4 to 85 years of age carried out an implicit task involving probabilistic sequences. They found difference in implicit learning of high- vs. low-probability events, measured by raw reaction times (RTs), with a rapid decrement around the age of 12. They also noted a sharp decline in old age.

In another study investigating age and implicit learning, Nemeth, Janacsek, and Fiser (2013) examined the performance of five age groups' (11 to 39 years of age) in a sequence learning task using probabilistic sequences. They found an age-related decline in statistical learning (RT differences between random low- and random high-frequency triplets) in an implicit condition with age invariant performance in an explicit condition. The youngest age group showed superior performance in the implicit condition relative to the explicit condition, whereas the opposite pattern was found for participant age groups between 19 and 39 years of age. They interpret the findings as showing that greater use of complex internal models optimizes skill-learning abilities by compensating for performance loss that results from down-weighting the raw probabilities in sensory input.

The claim that a SPE can be attributed to attenuated implicit learning abilities is controversial. A number of researchers in the field claim that implicit learning abilities remain constant throughout human development. Moreover, much of the research on

implicit learning has been in the general field of cognition, and as a result, the

applicability of the experimental paradigms to L1A and L2A has not been firmly

established. There is, however, an increasing body of evidence suggesting that the

general results in the area of implicit learning are relevant to natural language acquisition

and use (e.g., Conway, Bauernschmidt, Huang, & Pisoni, 2010; Misyak & Christiansen,

2012).

In sum, the current study will adopt the theoretical position that SLA research

provides strong evidence for a SP. The offset of this period is likely to be different for

different facets of language (DeKeyser & Larson-Hall, 2005; Long, 2013) . Even so,

studies suggest a general cut off around mid-teens for morphology and syntax. It will

furthermore be assumed that a key mechanism that underlies the SP for L2 acquisition is

a decline in implicit learning mechanisms that track probabilistic patterns in the

environment. For this reason, a crucial test of the SPH would be whether child and adult

learners display marked differences in their ability to acquire linguistic regularities when

the target form-meaning patterns are complex or are probabilistic. Ideal target features for

such an investigation would be sound-symbolic patterns, since the form-meaning patterns

in this area are neither regular nor entirely predictable, and since these patterns are

difficult to learn using explicit learning mechanisms. Before turning to a discussion of

these patterns, the dissertation will examine the relationship between language aptitude

and the SPH.

1.8 Language Aptitude and the SPH

One objection to the SPH has been the observation that some later learners appear (according to some studies) to reach nativelike levels of linguistic competence after the purported end of the SP. This objection is based on reports of some highly successful adult learners (e.g., the learners discussed in Ioup et al., 1994). Putting aside the question as to whether such success stories should count as counter-evidence for the SPH, there is still a need to account for the exceptional abilities of these learners, who appear to be less susceptible to the SPE. DeKeyser (2003), summarizing research on aptitude, age, and L2A, concludes that aptitude appears to be more important for older learners who are beyond the SP, with higher aptitude mitigating, to some extent, the SPE.[9] He notes that aptitude's facilitative effects have been observed for both classroom and naturalistic learners. DeKeyser claims that adult L2A draws heavily on explicit learning mechanisms; consequently, language aptitude related to explicit learning (e.g., analytical ability) should be a strong predictor of adult L2A success.

In this dissertation, language aptitude will be defined, following Caroll and Sapon (1959), as "basic abilities that are essential to facilitate foreign language learning" (p. 14). As the word "aptitude" suggests, this ability will be assumed to be a fairly stable trait that changes little throughout the lifetime. Moreover, it will be viewed as consisting of a complex array of components.

Researchers' early interest in the development of aptitude measures such as the MLAT (Modern Language Aptitude Test, Caroll & Sapon, 1959) and PLAB (Pimsleur Language Aptitude Battery, Pimsleur, 1966) was motivated by the need to predict the success of adult learners in foreign language courses. These tests, however, were found to

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[9] For a study examining the role of aptitude (along with other factors) among child L2 learners, see Paradis (2011).

be useful in predicting rate of learning in conventional foreign language courses, not ultimate attainment. Additionally, such tests would be better measures of language analytical ability rather than the capacity to learn language implicitly via the induction of regularities from noisy input.

In the half century since the development of these tests, some progress has been made in understanding the underlying components of aptitude. Few, yet still notable, studies have been performed testing the cognitive importance of implicit aptitude for L2 learning. For example, Kaufman et al. (2010) provided evidence for the hypothesis that there exist individual differences in implicit learning comparable to the individual differences in explicit learning. This challenges previous studies (e.g., Reber, 1993) that posit minimal individual differences in implicit processes. Implicit learning was found to be significantly correlated with processing speed and scores on the verbal reasoning test, but unrelated to working memory and explicit associative learning. Misyak and Christiansen (2012) further explored the importance of implicit learning on language learning through research of implicit aptitude's relationship with verbal working memory, short-term memory, vocabulary, reading experience, cognitive motivation, and fluid intelligence.

There is a collection of relevant findings in L2 aptitude literature. All the referenced studies have found evidence that individual differences in language aptitude relate to ultimate L2 attainment (see Table 3). In terms of grammaticality judgment, significant correlations were found between test performance and various measures of language aptitude as analytic ability (e.g., Abrahamsson & Hyltenstam, 2008; DeKeyser, 2000).

Relatively more recent studies have increasingly relied on LLAMA (Meara, 2005) as a measure of language aptitude (e.g., Abrahamsson & Hyltenstam, 2008; Bylund, Abrahamsson, & Hyltenstam, 2010; Forsberg Lundell & Sandgren, 2013; Granena, 2012; Granena & Long, 2013a), in addition to beginning to analyze the effects of LLAMA subtests on different language areas. Forsberg Lundell and Sandgren (2013), for example, have found that the acquisition of collocational knowledge correlates positively with LLAMA D (sound recognition) performance, but the relationship with test performance and other LLAMA subtests were not statistically significant. Although Granena and Long (2013a) also investigated the effect of LLAMA proficiency on collocational sensitivities, the study design included different AO groupings rather than only testing a subset of highly proficient adult L2 learners as in Forsberg Lundell and Sandgren (2013). Several notable studies have found that the strongest relationship between LLAMA performance and L2 proficiency was found in late-teen or adult age groups (Forsberg Lundell & Sandgren, 2013; Granena & Long, 2013a), and not for child learners, suggesting that AO groups are differentially affected by individual differences in language aptitude.

In sum, a growing body of research is discovering that specific types of language aptitude have varying effects on different language areas, suggesting that the relationship between aptitude and L2 attainment is much more complex than previously assumed.

Table 3.

Research on the Relationship between Aptitude and Ultimate L2 Attainment

Study	L1	L2	*N*	LoR Range	AoA Range	Aptitude Measure	Other Dependent Variable	Correlation/ Findings
DeKeyser (2000)	Hun.	Eng.	57	34		MLAT	unspeeded Oral GJT	AO 1-15, $r = .07$ AO 16-40, $r = .33$
Abraham-sson & Hylten-stam (2008)	Sp.	Sw.		> 20		LAT	GJT (written & auditory)	AO < 12, $r = .70$ AO > 12. $r = .53$
DeKeyser, Alfi-Shabtay, & Ravid (2010)	Rus.	Eng. Heb.	140	11		Inter-University Psychometric Entrance Test	unspeeded oral GJT	AO < 18, $r = .11$, $r = .37$ AO 18-40, $r = .44$, $r = .45$ AO > 40, $r = .33$, $r = .17$
Granena (2012)	Ch.	Sp.	100	11-28 5-20	3-6 >16	LLAMA LLAMA D	morphosyntax gender, number, person sensitivity	different types of aptitudes (i.e., implicit/explicit) have different effect on L2 outcomes (controlled/automatic use of L2 knowledge)
Granena & Long (2013)	Ch.	Sp.	57	34		LLAMA (esp. D)	pronunciation collocation knowledge	significant correlations were found in pronunciation and collocation in the AO 16-29.
Forsberg Lundell & Sandgren (2013)	Swed.	Fr.	13	5-35	17-21	LLAMA D	collocations	significant correlations found in collocations in the AO 13-17.

1.9 Aptitude Measure

A number of recent studies have used the LLAMA test. This aptitude test was developed by Meara (2005) based on an earlier test called the LAT (Meara, Milton, & Lorenzo-Dus, 2003). The test is computerized and can be downloaded for free.[10] Designed to be reliable for learners from a wide range of L1s, it has recently been used in a number of age-related studies in the field of SLA (e.g., Forsberg Lundell & Sandgren, 2013; Granena & Long, 2013a).

The LLAMA consists of a battery of tests that can be administered in about 25 minutes. LLAMA B is a test of vocabulary learning ability; LLAMA D tests participants' ability to identify previously heard sound sequences in new contexts; LLAMA E tests sound-symbol associations; and LLAMA F is a test of grammatical inferencing. While taking the test, test-takers hear feedback in the form of an acoustic signal. Scores on sub-test D range from 0 to 75 and scores on the other sub-tests (B, E, and F) range from 0 to 100. A detailed description of each component can be found in Granena (2013a).

Granena (2013a), in a review of 11 studies using the LLAMA, concluded that there was a significant correlation between language aptitude as measured by the LLAMA and L2 outcome measures associated with both immersion and instructed contexts. As she points out, most of the LLAMA components correlate well with measures involving analytic and metalinguistic abilities and with learning under explicit treatments. The exception is the LLAMA D, the sound recognition subtest, which showed high correlations with sensitivity to agreement violations and collocational knowledge,

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[10] The test is available at: http://www.lognostics.co.uk/tools/llama/

types of knowledge that are associated with the implicit inductive learning of patterns within massive amounts of input.

Granena (2013a) performed an exploratory evaluation of the LLAMA with 186 learners from Chinese, English, and Spanish backgrounds. The scores were similar for the three L1 groups and both genders, and the scores fell into normal distributions. The internal consistency of the battery (using an available subset of participants) was acceptable, with ($\alpha = .77$). Cronbach's alpha for the components (B, D, E, and F) were .76, .64, .63, and .60 respectively. Test-retest reliability was measured by testing participants at a two-year interval. The correlation for the test-retest scores for the entire battery was .64 ($p < .01$). The LLAMA D subtest showed low correlations with other components, suggesting that the underlying component of aptitude that it measures is relatively independent.

Granena (2013a) performed a principal component analysis on the LLAMA subtests, the general intelligence test (GAMA) and a probabilistic serial reaction time task. The LLAMA D subtest loaded on the same component as the SRT task (considered to be a measure of implicit learning) while LLAMA B, E, and F loaded with general intelligence, a construct that is thought to be biased toward explicit learning capabilities (for a discussion, see Granena, 2013b).

CHAPTER 2: SOUND SYMBOLISM

2.1 Introduction

Sound symbolism (SS) shall be defined in this dissertation as *a correspondence, occurring at a rate greater than would be expected by chance, between meaning and phonological form, at a level that is smaller than words or morphemes*. The phrase *at a rate greater than expected* is intentionally vague so as to include the possibility that sound-symbolic patterns are primarily associated with token or type frequency (or some combination of both) or are associated with particular distributional patterns. This is a slightly expanded version of the definition that Bergen (2004) provides for phonesthemes: "Form-meaning pairings that crucially are better attested in the lexicon of the language than would be predicted, all other things being equal" (p. 293). Nuckolls (1999), on the other hand, defines SS as referring to instances in which "a sound unit such as a phoneme, syllable, feature or tone is said to go beyond its linguistic function as a contrastive, non-meaning bearing unit to directly express some kind of meaning" (pp. 228). The definition is not adopted here as it does not include explicit reference to the fact that the form-meaning correspondences in SS exhibit a biased distribution within a language. Moreover, it will be argued that the definition should be theory-neutral: That is to say, it should not assume a position on the question of whether SS has an iconic basis.[11]

SS has been discussed in classical philosophical texts (e.g., the *Upanishads*). Socrates, in the *Cratylus*, provides an early discussion of sound-symbolism. In the following passage, he suggests that the Greek [ρ] sound was, during the ancient formation

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[11] The theoretical discussion of a possible iconic basis for SS will be discussed later in the dissertation.

of language, associated with specific abstract meaning based on iconic links between the movement of the organs of speech and the semantics of the coined words.

Now the letter rho, as I was saying, appeared to the imposer of names an excellent instrument for the expression of motion; and he frequently uses the letter for this purpose: for example, in the actual words *rein* and *roe* he represents motion by rho; also in the words *tromos* (trembling), *trachus* (rugged); and again, in words such as *krouein* (strike), *thrauein* (crush), *ereikein* (strike) . . . *rubein* (whirl): of all these sorts of movements he generally finds an expression in the letter R, because, as I imagine, he had observed that the tongue was most agitated and least at rest in the pronunciation of this letter, which he therefore used in order to express motion" (Plato, 409 B.C.E./2008, p. 159, italics added).

More broadly, the interest in rhyme and word play in most societies may reflect a general sense that words that share phonological elements often have subtle thematic relationships. Within European linguistics, SS was discussed in a number of early works. For example, Wallis (1653), cited in (Drellishak, 2007), mentions sound-symbolic relationships.

As the field of linguistics developed in Europe, several key thinkers expressed skepticism regarding the existence of SS as a driving force in language. Locke (1689/1829) suggested that the idea was incompatible with the existence of multiple languages: "Thus we can conceive how words . . . came to be made use of by men, as the signs of their ideas; not by any natural connection that there is between particular articulate sounds and certain ideas; for then there would be but one language amongst all

men; but by a voluntary imposition, whereby such a word is made arbitrarily the mark of such an idea" (p. 291).

Saussure (1959), in his discussion of the semiological distinction between the signified (i.e., a concept), the signifier (i.e., the mental representation of a sound), and the sign (the linguistic bond linking the signified [*signifié*] with the signifier [*signifiant*], noted that a fundamental characteristic of the sign was that it was arbitrary. He regarded the matter as settled since "no one disputes the principle of the arbitrary nature of the sign" (p. 68). Saussure, echoing Locke before him, held that arbitrariness could be posited from the fact that languages differ[12] and from the very fact that different languages exist. Saussure was aware that onomatopoeia (a type of SS) represented a possible counter-example, but he dismissed the importance of such words on two grounds: (1) some words that appeared to be onomatopoeia were derived from words that originally were not onomatopoeic, and (2) words that are legitimate onomatopoeic coinages are limited and are, to some extent, conventionalized within the language system; Saussure, furthermore, claimed that the onomatopoeic features of these words quickly lost their sound symbolic qualities as they were fully incorporated into the linguistic system.

While many of Saussure's observations were astute and certainly apply to much of the linguistic system of many languages, they have been called into question on a number of grounds. First, there is evidence that sound symbolism plays a much greater role in many languages. Second, there is evidence that speakers of all languages are sensitive to sound symbolism, and that this sensitivity influences a number of important linguistic processes related to both language acquisition, the coining of new words, and

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[12] It should be noted that words denoting similar referents differ both *between* languages and *within* languages (e.g., *baby*, *infant*, and *tot*).

the selective maintenance (or slight alteration) of existing linguistic structures (for early discussion on these ideas, see Jesperson, 1933; Sapir, 1929). It should also be noted that Saussure, rather than totally denying the existence of non-arbitrary elements throughout existing languages, adopts the curious attitude that these elements, even when they are authentically non-arbitrary, do not belong to the study of linguistics proper. It may also be pointed out, as Ultan (1978) has stated, that the criterion that SS, to exist, must necessarily be the original diachronic motivation for a word seems to be overly stringent.

The study of SS has been plagued by a plethora of terminological distinctions, which have unfortunately obscured common themes and findings within this area of research. In many cases, a particular term will be chiefly associated with the investigation of SS related to a specific group of languages. For example, the preferred term for SS appears to be *ideophones* within research focused on African languages (e.g., Dingemanse, 2011; Fortune, 1962; P. Newman, 2001; Samarin, 1965; Voeltz & Kilian-Hatz, 2001). Doke (1935) says that an *ideophone* is a vivid representation of an idea in sound, and is "a word, often onomatopoetic, which describes a predicate, qualitative or adverb in respect to manner, colour, sound, smell, action, state or intensity" (p. 118). Dingemanse (2011) has attempted to narrow and simplify this with his definition of *ideophones* as "marked words that depict sensory imagery" (p. 25). Dingemanse's use of "marked" in the definition is in reference to ideophones' phonological shape, expressive morphology, relative syntactic independence, and foregrounded prosody. In short, ideophones are said to be perceived as a distinct word class by speakers. In research on south-east Asian languages (e.g., Diffloth, 1976), researchers have often referred to a specific class of sound-symbolic words as *expressives.*

SS plays an important role in both Korean and Japanese. Consequently, Korean and Japanese linguists have developed a fairly fine-grained terminological tool-chest without a commonly employed, overarching term for the general phenomenon. Using the same Chinese character compounds for the terms, Koreans and Japanese linguists refer to phonomimes, or onomatopoeic words, with an iconic relationship to the sound of a referent, as 擬声語 (Korean *uysenge*, Japanese *giseigo*), and refer to phenomimes[13] (words that mimic a physical form or motion) as 擬態語 (Korean *uythaye*, Japanese *gitaigo*). These researchers also sometimes refer to psychomimes (words describing emotions or sensations) as 擬情語 (Korean *uycenge*, Japanese *gijōgo*). As J.-S. Lee (1992) points out, this excessive carving up of this area of study into detailed nomenclatures can result in a number of problems, such as classification problems when words are associated with more than one semantic category (e.g., both sound and manner).

In work on SS in English, much of the research has employed the term *onomatopoeia* for words with clear sound-related iconicity. Relative to many non-Indo-European languages, English has a large repertoire of consonant clusters, so much of the SS research related to English has focused on the initial or final parts of words, especially on phoneme sequences. The term most closely associated with this line of research is *phonestheme*, which was coined by Firth (1930/1964, p. 184). Firth claimed that phonetic patterns could be found in both the initial or final parts of words and that knowledge of these patterns existed at an unconscious level (i.e., the knowledge was implicit). He also noted that phonesthemes did not necessarily reflect words' common etymologies. Firth

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[13] Shibatani (1990) defines *phenomimes* in a somewhat vague manner as words that depict "states, conditions, or manners of the external world" (p. 154).

felt that nearly all phonesthemes (except perhaps some sibilants) were not based on any inherent iconic value but were instead acquired through input.

The abundance of terms reflects the fact that sound symbolism operates differently in the world's various languages. However, there are a number of common tendencies that sound-symbolic systems often share. For example, words with clear sound-symbolic elements tend to be content, not function words, and they tend to appear at the subordinate[14] vs. superordinate or basic level of categories (Bergen, 2004). In African languages such as Shona (1962) and Hausa (1962) and Asian languages such as Korean (Chae, 2000) and Japanese (Hamano, 1998), SS tends to be associated with highly expressive language.

The semantic contribution of the sound-symbolic elements themselves, on the other hand, are associated with highly abstract categories such as sounds (Marks, 1974), colors (Allott, 1974; Langer & Rosenberg, 1996; Marks, 1974), textures (Spence & Ngo, 2012), motion (Cuskley, 2012; Shintel & Nusbaum, 2007), proximity (Tanz, 1971), emotions (Auracher, Albers, Zhai, & Gareeva, 2010; Do & Lee, 2011), size (Bentley & Varon, 1933; Diffloth, 1994; Jesperson, 1933), tastes (Crisinel, Jones, & Spence, 2012; Simner, Cuskley, & Kirby, 2010; Spence & Ngo, 2012; Stutts & Torres, 2012), and shapes (Ahlner & J., 2010; Aveyard, 2012; Kohler, 1929; Kovic, Plunkett, & Westermann, 2010; H. Lee, 2009; Maurer, Pathman, & Mondloch, 2006; Nielsen & Rendall, 2011; Ozturk, Krehm, & Vouloumanos, 2012; Spence, 2011, 2012; Spence & Ngo, 2012; Westbury, 2005),

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[14] The subordinate level denotes terms that are more marked and thus less common. An example of a basic level term would be the word *chair*. Its superordinate counterpart would be the word *furniture*, and its subordinate counterpart would be a word such as *armchair*.

Many of these categories also convey the sort of abstract information marked by closed-class items such as grammatical affixes or classifiers. The few categories that are exceptions (e.g., color) may be derivative from a more fundamental distinction (e.g., intensity or magnitude). It is quite possible that sound symbolism arises in a very limited number of core semantic domains and is then extended to other domains as a result of metaphorical transfer. There is evidence that this type of semantic shift is regular and directional (Shen & Cohen, 1998; Sweetser, 1990). Williams (1976) notes, for example, that words associated with touch have been shown to shift so as to refer to tastes (e.g., *sharp tastes*), smells, colors (e.g., *dull colors*), or sounds (e.g., *a soft tone*). This being the case, sound symbolism that originally developed in association with tactile sensations may transfer to the domains of tastes, odors, or sounds.

Within a given language, SS also tends to be associated with specific parts of speech. For example, SS occurs more frequently in adverbs in Korean (J.-S. Lee, 1992) and Japanese (Caldwell, 2009). These constraints are often used to define sound-symbolic word classes within a language (e.g., the criteria put forth byJ.-S. Lee, 1992, for Korean). By definition, SS occurs at the submorphemic level. Martin (1962) gives the example of the aspiration that occurs in the final syllable (*kho*) in the Korean word *camcakho* (without a word). He derives the word from *camcako* (*camca* = to sleep, *ko* = and). The example is interesting since the aspiration that, according to Martin, denotes intensity, actually occurs outside of the verb that is undergoing intensification.[15]

Throughout the world's languages, similar phonemes or features are often associated with similar meaning. For example, nasals often denote unpleasantness

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[15] Martin (1962) exemplifies this word (*camcakho*) as being an unusual case because intensification occurs in the final consonant ($k \rightarrow k^h$) rather than in the initial consonant of the word.

(Auracher et al., 2010); reduplication is associated with iteration of an event; the vowel /a/ is often associated with large size (Sapir, 1929), and so on. However, there is also ample evidence that some sound-symbolic patterns are language specific (Taylor & Taylor, 1962). For example, the association of /a/ with large size and /i/ with small size that is often cited as an example of a universal trend in SS has been found to have a number of exceptions in, to cite a few examples, the sound-symbolic systems in Nez Perce (Aoki, 1994), Northern Sahaptin (Ultan, 1978), a Vietnamese dialect (Diffloth, 1994), and Korean.[16]

2.2 Korean Sound Symbolism

Before turning to the experiments, it would be useful to provide some background regarding Korean SS. The purpose of this is two-fold. First, the experiments will measure Korean NSs' acquisition of English sound-symbolic patterns. A basic knowledge of Korean SS is therefore necessary to understand the learning problem that English SS poses for these learners. It is important, for example, to know the degree of similarity between the two systems. Second, Korean SS, like SS in Japanese but unlike SS in English, is highly systematic. Discussion of the system is therefore helpful in establishing the extent to which SS can function as a pervasive feature within language.

Korean sound-symbolic words are a fairly distinct linguistic category that is characterized by a cluster of features. On the one hand, they typically involve phonetic

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[16] During piloting of potential materials for the experiments proposed in this paper, native Korean speaking adults showed a great deal of variation in the intuitions regarding this distinction. Although /a/ and /i/ appear to be associated with small and large size respectively in the more systematic portions of Korean's sound-symbolic lexicon, the association may not be consistent in the other portions of the lexicon. See also the related discussion in K.-o. Kim (1977), Ohala (1994), and Tsur (2006). It is interesting to note that at least three of the languages that have been discussed as exceptions to the "/a/ is big, /i/ is small" rule have vowel harmony.

play involving consonant mutation (often involving the contrast between unaspirated, aspirated, and tensed consonants) and vowel play. The latter is typically characterized by vowel ablaut patterns in which "light" vowels (i.e., /æ/, /a/, /o/) denote a range of meanings associated with small size, cuteness, and so on, whereas "dark" or "heavy" vowels (i.e., /i/, /e/, /ɪ/, /∂/, /u/) denote large size, augmentative meanings, and so on. Due to vowel harmony rules, light and heavy vowels cannot co-occur in SS words. However, /i/ and /ɪ/ are regarded as neutral vowels when they occur within non-initial syllables. These restrictions in the sound-symbolic lexicon contrast with the mixing of both vowel types in Korean prosaic (i.e., non-sound-symbolic) words.

In the Korean SS system, the three vowels /a/, /o/, and /æ/ are regarded as "light" vowels and are therefore associated with small size or with something delicate, fragile, bright, or airy (J.-S. Lee, 1992; Martin, 1962). The four vowels /i/, /ə/, /u/, and /e/, on the other hand, are regarded as "dark" vowels, and are therefore associated with things that are heavy, bulky, unwieldy, or gloomy[17] (J.-S. Lee, 1992; Martin, 1962).

Korean SS related to magnitude is somewhat anomalous when viewed from a cross-linguistic perspective. As Ultan (1978) notes, diminutives in the world's languages (including English) are generally associated with high front vowels (e.g., the /i/ sound in *fee* or the /I/ sound in *bit*). The Korean "light" vowels tend to be low and/or back vowels. English, on the other hand, is thought to follow the more universal pattern.

Reduplication occurs frequently in Korean SS, where it expresses ampleness in terms of quantity or quality (J.-S. Lee, 1992). Examples abound. For example, the sound-

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[17] According to J.-S. Lee (1992), the gloomy connotation is associated with the SS of Korean prosaic words (i.e., words that do not belong to the more systematic component of the Korean SS system.) It should also be noted that English SS appears to be opposite in terms of the affective connotations of at least the /i/ sound, which Whissel (2003) has found to be associated with cheerfulness.

symbolic reduplicated form *colcol* (in a trickling manner) is again reduplicated in a common children's song: *Sinaysmwul un colcolcolcol kokitul un wasstakassta* (The creek's water goes "trickle trickle"; the fish dart back and forth). Although reduplication can occur in Korean prosaic words, it is more consistently associated with iteration in the sound-symbolic lexicon. Moreover, Korean sound-symbolic words may undergo multiple reduplication, whereas prosaic words cannot (J.-S. Lee, 1992). Full reduplication is possible for nearly all Korean sound-symbolic adverbs, but is not allowed for words that take certain adjectival affixes (e.g., *hata* or *i*). Some of the reduplicating type of sound-symbolic words can be changed from an adverb into a verb or an adjective (using the attributive form of the verb) through the addition of the verb *kelita*. Sound-symbolic words can also undergo a sort of faulty reduplication, which is associated with directionlessness and aimlessness (J.-S. Lee, 1992). As Lee points out, the semantic contribution of the pattern may explain why it sometimes violates vowel harmony constraints.

The features of phonetic play and reduplication combine to form paradigmatic sets of related word forms. All possible variations do not actually occur in each set, and in some cases, only a single form exists. In many cases, the omission of forms can be attributed to semantic overlap between the basic meaning of a form and the mutated form (J.-S. Lee, 1992). For example, a word denoting large size may lack an intensive form denoting largeness or may be incompatible with a diminutive form denoting small size. A typical sound-symbolic paradigm involving consonant play, vowel play, and reduplication are shown in Table 4. These are followed by explanations of the meanings.

The subtle modulation of meaning is often difficult to capture in the short English glosses

for each word.

Table 4.

An Example of Korean Sound-Symbolic Paradigms Involving Phonetic Play

Consonant play[18] →			
Vowel Play[19]↓	*palttak*	*phalttak*	*ppalttak*
	pəlttək	*phəlttək*	*ppəlttək*

palttak: Suddenly, used for smaller referents

Ku ottwuki-ka palttak ile-nass-ta.

That tumbler-Nom suddenly stand-Past-Indicative.

The tumbler suddenly stood up.

pəlttək: Suddenly, used for larger referents

Ku namca-ka pəlttək ile-nass-ta.

That man-Nom suddenly stand-Past-Indicative.

The man suddenly stood up.

phalttak: Suddenly (more intense), used for smaller referents

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[18] Korean exhibits phonemic contrasts based on laryngeal features, a three-way lax *p (plain)*, aspirated *ph (para-intensive)*, and tense *pp (intensive)* contrasts for syllable-initial stops (p, t, k). The alternation of those three differentiates connotations with respect to degrees of intensity.
[19] The vowel alternation between /a/ and /ə/ as in the case of *palttak* and *pəlttək* occurs in order to express the two contrastive semantic categories (i.e., small vs. large).

Ku ottwuki-ka phalttak ile-nass-ta.

That tumbler-Nom suddenly stand-Past-Indicative.

The tumbler suddenly stood up swiftly (almost making a wind).

phəlttək: Suddenly (more intense), used for larger referents

Ku namcaka phəlttək ile-nass-ta.

That man-Nom suddenly stand-Past-Indicative.

The man suddenly stood up swiftly (almost making a wind).

ppalttak: Suddenly (with vigor), used for smaller referents

Ku ottwuki-ka ppalttak ile-nass-ta.

That tumbler-Nom suddenly stand-Past-Indicative.

The tumbler very suddenly stood up (with energy).

ppəlttək: Suddenly (with vigor), used for larger referents

Ku namcaka ppəlttək ile-nass-ta.

That man-Nom suddenly stand-Past-Indicative.

 The man very suddenly stood up (with energy).

In all the examples, the vowel of the second syllable follows vowel harmony constraints. This results in the vowels being identical; however, the vowels can be different as long as they constitute the same vowel type (i.e., a light vowel following a light vowel, or a dark vowel following a dark vowel). For example, the second vowel (/u/)

is regarded as neutral when occurring in non-initial positions, so the second vowel does not need to change form in order to meet vowel harmony constraints. A good example of such a paradigm involves adverbs describing the manner of an object's spinning: *pængkul* (in a spinning manner, small object), *pingkul* (in a spinning manner, large object), *phængkul* (in a spinning and energetic manner, small object), *phingkul* (in a spinning and energetic manner, large object), *ppængkul* (in a swiftly spinning manner, small object), and *ppiyngkul* (in a swiftly spinning manner, large object). This paradigm of six forms can be further expanded through the use of reduplication: *pængkul pængkul* (in a repetitively spinning manner, small object). It should be noted that in both examples, /æ/ is associated with small size and /i/ with large size in direct opposition to the typical symbolism of these vowels in most of the world's languages. This reversal is typical in Korean sound-symbolic words.

According to J.-S. Lee (1992), Korean lacks phonemes that are restricted to expressive vocabulary[20]. This should not be understood to imply that nonphonemic contrasts are not part of Korean SS. For example, if voicing contrasts are considered, the devoiced vowels in some Korean SS words, particularly in words with a lengthened initial vowel, would seem to be a good example of Korean SS aimed at expressing augmentation. When giving directions, for example, Korean speakers will often use the adverb *ccwuk* (straight) when telling someone to "go straight ahead." When the distance is far, the word often undergoes iconic lengthening (*ccwuwuk*), and when the distance is

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[20] The Korean sound symbolic system adheres to a regular phonological inventory and rarely violates phonotactic constraints. It is less likely to have phonemes that can be used exclusively in mimetic words to evoke sensations. This is not the case in *expressives*, the sound-symbolic words of South-Eastern Asian languages. For example, in Lao, *expressives* with stop finals use different tone structures from ordinary vocabulary; expressive *kyp* 'snugly' has a level tone although non-expressive words with stop finals would usually have a high-rising tone (Crisfield, 1983, p.44).

especially far, a hoarse devoiced vowel, which is not part of the regular Korean phonemic

inventory, is produced with some qualities similar to a voiceless velar fricative (e.g., the

production of turbulence through constriction of air flow). The form's iconic basis may

come from the association between difficulty in pronunciation and the implied effort

required to traverse long distances (which may also explain why this voicing is often

accompanied by a squinting expression).

In sum, Korean SS is an important, elaborate, and pervasive feature of the

language. An ability to utilize the SS system is regarded as an essential component of

Korean NSs' knowledge of their own language. The importance of the system is reflected

in the abundance of pedagogy-oriented studies and language materials developed for both

NSs (e.g., Chu, 2007) and L2 learners of Korean (e.g., H. S. Bae, 2006; J.-s. Kim, 2001).

2.3 English Sound Symbolism

In contrast with languages such as Korean and Japanese, which have highly

systematic SS systems, English and other Indo-European languages have been described

as having little SS outside of highly iconic onomatopoeia (e.g., the cat's meow, etc.).

However, some researchers have questioned this assessment. Abelin (1999), in his

examination of Swedish, claims that virtually all initial consonant clusters and nearly a

quarter of final clusters are used for SS. Rhodes and Lawler (1981) estimate that half of

English monosyllables are analyzable in terms of SS.

Whereas research on SS in Korean has focused primarily on a specific class of

words (i.e., those that occur frequently as adverbs and are characterized by systematic

vowel and consonant play), studies on English SS have focused more on the assonance (a

word's initial consonant or consonant clusters) and rime of words, a terminological

distinction, originally developed by Bolinger (1950), that remains in common use in

recent research on SS (e.g., Parault, 2002; Rhodes, 1994). The term *assonance*, used in

this specialized sense, should not be confused with the more general use of the term (i.e.,

to refer to use of the same or similar vowels in discussions of literature and poetry). An

oft-cited example of an assonance would be the *gl-* sound at the beginning of words such

as *glitter* and *glow* (for a discussioin, see Boussidan, Sagi, & Ploux, 2009). In English,

the sound is generally associated with vision and light (especially, reflected light). An

example of a rime would be the *–ump* cluster, which is associated with small, often

curved 3-D objects that tend to form temporary impediments, as evident in the words

bump, *hump*, *clump*, and *stump*. Technically, in disyllabic words, the term *rime* refers to

nucleus and coda of the first stressed syllable (Lawler, 2006b).[21]

English SS associated with initial consonant clusters and rimes is probably, to

some extent, derived from associations between individual consonants, vowels, or

phonological features (e.g., voicing). Some research has examined English SS in terms of

these more fine-grained components. Pitcher, Mesoudi, and McElligott (2013), for

example, examined a data set of American, Australian, and British first names. They

transcribed names into IPA values. The assignment of vowel phonemes as either sound-

symbolically large or small was based on R. C. Johnson (1967), so that the phonemes /i, I,

I:, e, aI, ɒ, ʌ/ were regarded as small and the phonemes /u:, ə, æ, eI, aʊ, a:, o/ were

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[21] Rhodes and Lawler (1981) have claimed that the assonance and rime combine in a systematic manner, with the assonance serving as the modifier and the rime serving as the head of the construction. They claim that the assonance is thereby relatively richer in meaning and that it functions much like classifiers in classifier systems, referring to semantic properties such as human, animate, gender, and physical state (e.g. solid, liquid, etc.) Assonances are said to be much more coherent, with meanings similar to that of rimes. In a manner similar to Korean vowel play, rimes are said to be subject to derivational processes, particularly changes in vowels to denote diminution (e.g., teat/tit, stake-stick, drop-drip, etc.). However, this process is said to be irregular, resulting in unpredictable semantic shifts (Lawler, 2006a).

regarded as large. Any other phonemes were classified along similar lines as either high

front (small) or low back (large).

For boys' names, the study found that the vowel of the stressed syllable was

significantly more likely to have a "large" phoneme: $\chi2$ (1, $N = 229$) = 8.84, $p = 0.003$,

whereas girls' names were significantly more likely to have a "small" phoneme in the

stressed position: $\chi2$ (1, $N = 238$) = 6.72, $p = 0.01$. In their interpretation of their findings,

they note that the apparent sound-symbolic association of names such as "Thomas" with

boys and names such as "Emily" with girls reflects societal ideals in Western society (the

preference for large, physically strong men and petite women), and that the findings are

congruent with prior work on SS, particularly with the Frequency Code Hypothesis

(Ohala, 1994) and related work (e.g., Chuenwattanapranithi, Xu, Thipakorn, &

Naneewongvatana, 2008).

Findings of research on English SS have generally found patterns similar to those

found in other languages around the world. It should be noted that many of the purported

sound-symbolic values for English vowels, in terms of their association with magnitude,

are the opposite of those assigned to Korean vowels by mainstream analysis within the

Korean linguistic tradition (e.g., J.-S. Lee, 1992; Martin, 1962). Figure 1 shows English

associations according to frontness and height (Ohala, 1984; Thompson & Estes, 2011)

and based on the results of piloting (discussed below). Figure 2 shows the equivalent

Korean vowels in their approximate positions in an English vowel chart with their

magnitude associations based on mainstream linguistic analysis (e.g., J.-S. Lee, 1992).

Sound-symbolic associations with large magnitude have been shown with squares, and

associations with small magnitude have been shown with circles. As can be seen, the

associations for many of the vowels are opposed in the two languages. These differences

will be exploited in the design of materials for the experiments described later in the

dissertation.
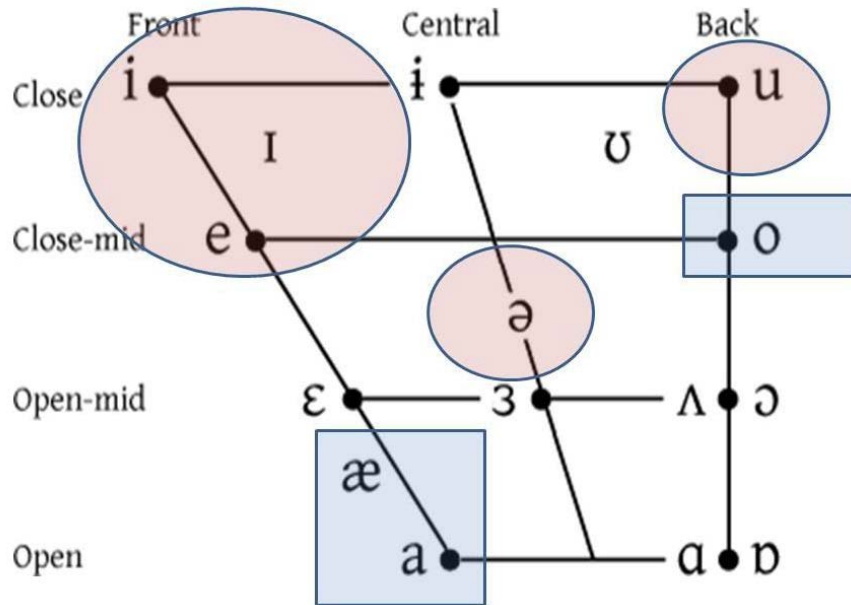
Figure 1. Magnitude-related English SS (large associations = squares, small = circles).

Colors are provided for a more distinct contrast between the shapes.
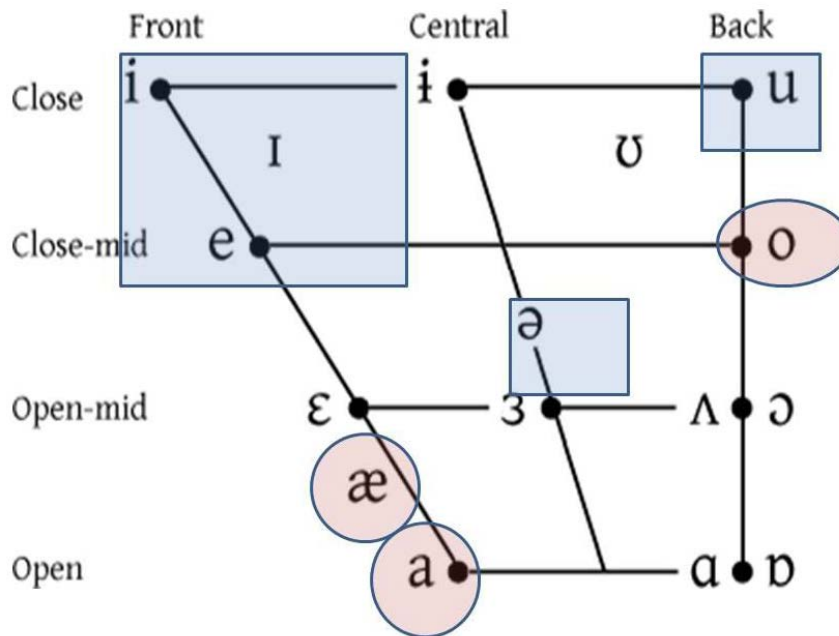
Figure 2. Magnitude-related Korean SS (large associations = squares, small = circles).

2.4 Mechanisms Underlying the Emergence of Sound Symbolism in Languages

Having examined SS in Korean, a language that is renowned for the richness of its sound-symbolic system, and English, it is now time to turn to the question of why SS develops within languages. This question is important within the context of the current research, since the diachronic processes that are responsible for the emergence of sound-symbolic patterns over time are likely to reflect synchronic cognitive processes of individual speakers.[22] One alternative to the premise that diachronic and synchronic developments are linked is the idea that sound-symbolic patterns reflect common

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[22] SS literature has theorized that synchronic variation based on iconicity play a role in diachronic change. Jespersen (1992) has posited that lexical items that have more iconic form-meaning associations tend to be more resistant to phonological alterations. In other words, lexical items with congruent SS criteria will be more stable. For example, consider the English word *cuckoo* that defines a family of bird breeds. The first vowel would be expected to be pronounced [ʌ] as in *cut*, but instead remains [u]. The sound symbolic [u] sound resists phonological change.

remnants of an ancient ancestral language. While there is some evidence that SS can be remarkably resistant to change within language families (Blust, 2003), the proto-language explanation seems implausible in light of the long span of time during which human languages are thought to have used language and the inevitable nature of phonological shifts, which tend to erode and transform phonological patterns. In fact, the widespread existence of SS in spite of phonological change suggests that it reflects pervasive ongoing cognitive processes.

One candidate for such a process, put forth by Ohala (1983, 1994, 1995), is the Frequency Code Hypothesis. Ohala notes that both humans and animals can use the frequency of a vocalization to estimate the size of an adversary. Animals, such as apes, will exploit this fact by expanding the vocal tract so as to produce lower formant frequencies when making threats (consider, for example, the open-mouthed roar of an ape or a lion). For the same reason, animals will minimize the size of the oral cavity (creating a high F0) when attempting to show submission (consider, for example, the smiling whimpering of a monkey or dog trying to appease a dominant animal of human owner). According to this hypothesis, SS reflects the incorporation of such information into conventionalized language.[23] Gordon and Heath (1998) have sought a similar explanatory link between the acoustic differences in male/female voices and sound symbolism.[24]

Because it is grounded in basic facts about the effects of human size on features of vocalizations, the Frequency Code Hypothesis would predict that SS across languages would be nearly identical. Some research suggests that SS does, in fact, have

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[23] For a general discussion of human perception of intonation features, see Vaissière (2005).

[24] Klink (2009) has examined this link in the context of marketing and brand preferences. It should be noted that masculine and feminine noun class could also be viewed as being ultimately derived from sound symbolism.

considerable crosslinguistic consistency (Ciccotosto, 1991; Iwasaki, Vinson, & Vigliocco, 2007b). However, there is also some crosslinguistic variation, such as reversals in the size-symbolism associated with vowels that was discussed previously. Such differences suggest that SS has multiple origins.

It could be, for example, that speakers, instead of focusing on the iconicity associated with acoustic differences, are focusing on the shape of individual speech organs such as that of the tongue or the oral cavity. Such symbolism may ultimately be derived from the matching of facial gestures to vocalizations, for example, the child's smacking of the lips to express a desire for milk, which is thought to have given rise to the frequent use of words similar to *mama* to refer to mothers, breasts, or milk in the word's languages. Another example would be the Korean word *i* (tooth), which would seem to be derived from vocalization made while baring the teeth. In support of the view that articulatory gestures are often associated with sound-symbolic words, both Oda (2001) and Kantartzis (2011) found that participants' ability to guess the semantics of unknown mimetic words was enhanced if they pronounced the word.

Both the Frequency Code Hypothesis and iconicity based on facial gestures involve nonlinguistic experiential correlations that are eventually integrated into conventionalized language. It should be noted that many vocal features (e.g., raising the volume of one's voice, increasing the rate of speech, etc.) have iconic meaning but do not necessarily become integrated within a language's lexicon or grammar. In some cases, language-specific features may limit the opportunity to incorporate a particular iconic feature.

As an example of language-specific limiting factors, one might consider the occurrence of stiff voicing in Korean and English. Korean has three kinds of voiceless stops, typically described as aspirated /p^h t^h k^h/, lax or lenis /p t k/ (which are voiced medially) and tense or fortis /p* t* k*/. The fortis stops, which are articulated with a discernible degree of glottal constriction and subglottal pressure, are associated with a type of phonation known as stiff voicing (for a discussion, see M.-R. Kim & San, 2004; Ladefoged & Maddieson, 1996). Within the Korean system of SS, stiff voicing is associated with intensification.[25]

In English, on the other hand, stiff voicing is not phonemic, and adult English learners of Korean often experience difficulty in establishing separate representations for /p* t* k*/ when learning Korean. Even so, English NSs do occasionally make use of stops similar to Korean /p* t* k*/ in English, although no studies, to the best of my knowledge, have investigated the phenomenon. Specifically, English speakers will sometimes use these stops initially when using isolated expletives that begin with stops (e.g., the emphatic use of "Damn!" or "Bitch!) In such instances, the voicing can be viewed as the result of suppression of a vocalization, which results in the build-up in air pressure associated with stiff voicing. The expletive is regarded as inappropriate and is therefore suppressed, but the speaker, overcome with emotion, ends up "blurting out" the expletive, in spite of her or his best intentions.

Although stiff voicing is used in this instance, setting up an experiential correlation between emotional intensity and the voicing of syllables with initial stop consonants, the stiff voicing has not become systematically integrated within the English

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[25] Martin (1962) claims that its semantic contribution is distinct from that of aspiration, a claim that J.-S. Lee (1992) questions.

lexicon for the simple reason that English speakers do not have a representation of the sound within their phonemic inventory. In a sense, the experiential correlation has no point at which to enter the language (for a related discussion, see Yoshida, 2003).

The situation is different in Korean, which employs stiff voicing as a regular phonemic contrast in both word-initial and word-medial positions. It is interesting to note that in Korean, the voicing happens to have precisely the value that it would be expected to have based on its iconic basis in English: a sense of intensification.[26]

The final bases for SS which will be considered in this dissertation are probabilistic biases in the input. This is the idea that SS develops sporadically based on chance distributional biases of form-meaning pairings in a given language (for an early discussion of the idea, see Taylor & Taylor, 1962; Weiss, 1964a). As the sole explanation for SS, this would be inadequate, as it fails to explain strong universal tendencies in SS across languages. On the other hand, distributional features may be needed to account for language-specific features of SS. Without them, it is not clear why languages would fail to converge toward identical sound-symbolic systems due to individual speakers' similar sensitivity to the iconic bases of SS.

According to this view, chance distributional biases occur whenever a pattern becomes sufficiently pervasive to exert a centripetal force. Joseph (2001) describes this process in relationship to the final *–ag* sound that occurs in English words such as "drag."

> A good example of this process is afforded by the accumulation of words in
> English that end in *-ag* (earlier [-ag], now [-æg]) and have a general meaning
> connoting 'slow, tired, or tedious action', specifically drag 'lag behind',

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[26] This discussion should not be construed as a claim about the development of stiff voicing in Korea, but it is at least plausible that the suppressed voicing of emphatic utterances became associated, at some point, with intensity and that this association was eventually incorporated into the SS system in Korean.

fag 'grow weary', flag 'droop', and lag 'straggle', all attested in Middle

English but of various sources (some Scandinavian borrowings, some inherited

from earlier stages of English); at the point at which four words with both a

similar meaning and a similar form were present in the language, by roughly the

thirteenth century, an analysis was possible of this - *ag* as a (sub-) morphemic

element. That it had some reality as such a unit is shown by the fact that these

words "attracted" a semantically related word with a different form into their

"orbit" with a concomitant change in its form; sag 'sink, droop' in an early form

(sixteenth century) ended in -*k*, yet a perceived association with *drag/*

fag/flag/lag and the availability of –*ag* as a marker of that group brought it

more in line with the other members, giving ultimately *sag*. (p. 357)

Along similar lines, Beatty (1994) speculates that the Japanese sequence /ra/ is,

for Japanese L1 speakers, associated with monsters (e.g., the /ra/ in Gojira, the Japanese

name for Godzilla). While noting the general cross-linguistic tendency to associate /a/

with large size, Beatty suggests that the association may also be due to the existence of

Japanese words for large animals which happen to end in /ra/ (e.g., *kujira* for whale)[27]. If

this is true, it would suggest that speakers are able to induce very subtle statistic biases in

form-meaning associations within the input, and furthermore, that such associations

influence the ongoing process of word-formation within a language.

In sum, SS appears to arise as a result of experiential correlations associated with

phonetic symbolism (how a word sounds), gestural symbolism (how a word is said), and

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[27] According to Jespersen (1922), foreign words are more likely to be adopted as words in another
language when the sounds bear meaning that is similar to that language, e.g., *jungle* from hindi *jangal* is
easily acceptable as an English word due to its association with *jumble*, *tumble*, *bundle*, *bungle*.

stochastic biases (how often a pattern occurs). Both iconicity (via sound or gesture) and

distributional effects would be needed to account for both cross-linguistic similarities and

differences in SS systems. For this reason, the current study will take the position that

from a diachronic perspective, SS arises from both bases. However, from a synchronous

perspective, individual speakers are likely to be more influenced by distributional

patterns in the input. If this were not the case, the SS systems of the world would be

expected to rapidly converge as individual speakers developed representations based on

iconic elements that would be similar for human beings in general (e.g., correlations

between the size of the vocal tract and first formant frequencies). Finally, it should be

mentioned that an additional basis for SS that has not been discussed is the phenomenon

of synesthesia (Martino & Marks, 2001; Ramachandran & Hubbard, 2001).

Consideration of its role in SS will not be treated in the dissertation due to space

limitations.

2.5 Verification of the Presence of Sound Symbolism in Language

Having discussed the nature of SS, using some examples from Korean, the

dissertation will now turn to the verification of sound-symbolic patterns within languages

based on distributional biases in form-meaning mapping. Methodologically, the tendency

of a form to occur at greater-than-chance levels in association with a specific meaning

can be observed using either type or token counts. In current research, type counts are

typically used.

Most research involving analysis of types has been influenced by the researcher's

own intuitions based on observed patterns in the data. In her thesis research involving

over a dozen experiments and empirical investigations, Magnus (2001) has provided

perhaps the most comprehensive attempt to account for form-meaning sound-symbolic

correspondences in English. In a fairly exhaustive analysis of English words, she shows

that a given phoneme occurring with a specific environment (e.g., word initial) can

generally be associated with a limited number of semantic classes; moreover, other

phonemes generally are not associated with the same semantic classes.[28]

Lawler (1990, 2006) has sought to provide exhaustive analyses of specific

patterns by limiting his search to "simplex" words (those consisting of a monosyllable or

a trochaic disyllable ending with specific unstressed suffixes, with proper nouns and

productive derivational and inflectional suffixes excluded). One advantage of his analysis

is that it provides, in addition to semantic categories, ratings of the overall tendency of a

specific phoneme or phoneme cluster to be consistently associated with a set of meanings.

Otis and Sagi (2008) use Infomap (Schutze, 1997), a variant of Latent Semantic

Analysis (LSA), in their analysis of a corpus created from Project Gutenberg texts (token

count = 290 million words). This analysis creates a matrix based on measures of semantic

relatedness, which is operationalized in terms of the co-occurrence of words within a set

distance (e.g., how many times the word *swim* appears within 15 words of *water*). They

then used a Monte Carlo analysis to test the hypothesis that words sharing the same

phonestheme (using primarily phonaesthemes identified by Hutchins, 1998) were more

likely to share meaning relative to words chosen at random. Among Hutchins' list of 46

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[28] A number of earlier studies have also examined distributional biases in the association between phonemes and semantic classes. For example, S. S. Newman (1933), examining English SS associated with magnitude and brightness, concluded that the association between phonemes occurring in words (considered as types) and meaning was essentially random. He therefore concluded that sound-symbolic associations must have an iconic basis apart from distributional biases. Taylor (1963) has shown that Newman's data actually do show distribution biases that are significant at the $p = .05$ level.

possible phonesthemes, the authors discovered 27 phonesthemes that were statistically

reliable at an alpha of .05.

Research using LSA is a great improvement in this area of research as it

provides an empirical and objective method to verify sound-symbolic patterns that have

been put forth in linguistic analyses that rely heavily on researchers' intuitions.

Unfortunately, this area of research is in its infancy and has been carried out primarily in

proof-of-concept exploratory studies. Moreover, the tracking of distributional biases

through the analysis of corpora or word listings (e.g., dictionaries) can only be used to

show patterns in language: such techniques cannot be used to establish the psychological

reality of SS within individual speakers. Even so, the large body of linguistic analysis that

has identified patterns of SS and the crosslinguistic similarity of many of these patterns

provides strong evidence for the existence of SS in language.

2.6 Behavioral Studies of Sound Symbolism

Extensive research has attempted to provide verification of the psychological

reality of SS. Before discussing this research, it should be noted at the outset that the

notion that SS is psychologically real is not farfetched. The assumption is plausible in

light of other research demonstrating language users' ability to recognize subtle

correlations in the lexicon. Bergen (2004) mentions, as an example, speakers' ability to

perceive subtle relationships between gender and the phonology of names (Cassidy, Kelly,

& Sharoni, 1999; Cutler, McQueen, & Robinson, 1990), in spite of the fact that the form-

meaning correspondences in names are both non-categorical and non-compositional.[29]

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[29] Other examples provided by Bergen include English speakers' intuitions regarding irregular past tense
forms (Bybee & Moder, 1983; Bybee & Slobin, 1982), English speakers' awareness of phonological

Other research suggests that L1 learners are able to identify open and closed word classes based on phonological cues (Monaghan, Christiansen, & Charter, 2007). In other words, language users have been shown to be remarkably adept in their use of implicit knowledge of distributional features in language.

A number of studies, particularly earlier research conducted chiefly between the 1930s to the 1960s, involved the matching of words with sound-symbolic elements, to meanings. The studies indicated that this could be done at above-chance levels. Some of this research involved the use of nonce words. Other research used words from existing languages shown to subjects who did not know the languages. Depending on the study, words were presented orthographically or aurally. Most of the studies used a binary task in which participants had to select one of two antonyms. The studies have been listed below in Table 5.

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distributions of front and back vowels across word classes (Sereno, 1994), English speakers' use of correlations between grammatical category and phonological features to classify nonwords as nouns and verbs (Kelly & Bock, 1988)

Table 5.

Word Matching Studies Seeking to Verify the Psychological Validity of Sound Symbolism

Study	L1*	L2	*N*	Correct	Mode	α	Nonce	Word Type	Findings
Brown, Black, & Horowitz (1955)	Eng.	Chin., Czech, Hindi	86	58.9% 53.7% 59.6%	Writ.	.001 .001 .001	N	Antonyms: Diverse	Depending on language, between 61 and 70 participants scored above 50%.
Weiss (1966)	Eng.	Jpn.	294	53.8%	Writ.	.01	N	Sensation-related verbs & adjectives	Participants agreed on 60.8% of responses.
Klank, Huang, & Johnson (1971), Exp. 1	Eng.	Chin., Czech, Hindi, Jpn., Tahit.	240	50.8% - 57.0%	Writ.	null to .001	N	Both antonym & non-antonym pairs	Pairs from same end of semantic spectrum were not distinguished at above chance levels.
Atzet & Gerard (1965)	Nav.	Chin., Hindi	60		Aural	null	N	Antonyms: Diverse	Participants performed at chance levels (α = .01)
Siegel, Silverman, & Markel	Eng.	Chin., Czech, Hindi	61	57.0-60.1% 50.1-60.3%	Aur.+ Writ, Aural	.01-001 null-.001	N	Antonyms: Diverse	Only the aural-only condition for Hindi resulted in null findings.
Gebels (1969)	Eng.	O.H., S.M. Kiwai, Tong. Finn.	50	Not stated	Aur.+ Writ,	.05	N	Antonyms: Diverse	Participants performed at above-chance levels.
Taylor & Taylor (1962), Exp. 3	Eng. Jpn. Kor. Tam.	N/A	320				Y	Antonyms: Related to size, movement, warmth, & pleasantness	No correlations between L1 group responses were significant at a .01 level. Korean and English only showed a correlation of .240. Some semantic domains correlated, but these correlations were language-specific.
Birch & Erickson (Birch & Erickson, 1958)	Eng.	N/A	74		Aural		Y	Antonyms: Related to potency, activity, & evaluation	Correlations for responses were .73, .67, and .20 for three semantic areas respectively.

* Most of the studies simply state that the subjects were American university students. Most or perhaps all these students would have been English NSs.

While the studies provide some grounds for accepting the psychological reality of SS within languages, some of the results suggest influence from participants' L1s. Taylor and Taylor (1962, Exp. 3), in particular, shows a number of differences. Interestingly, the study found that the association of /a/ with large magnitude and /I/ with small magnitude, while clearly present in English, was not present in Korean. The Korean subjects actually rated /I/ as slightly larger.

Generally speaking, the word-matching experiments have demonstrated the surprising finding that participants can classify existing words in unknown languages at above-chance levels even when they have never learned or encountered the word; moreover, nonce-word matching shows correlations between responses of participants speaking the same L1 and, in some studies (particularly those involving tasks targeting semantic categories such as magnitude) similar choices among speakers of unrelated languages.

The above-chance findings for words presented orthographically are somewhat unexpected in light of the fact that the transliteration systems for foreign words are often opaque to linguistically naïve participants. One must wonder, after all, how many of the participants in the Brown, Black, and Horowitz (1955) study, when viewing the Romanization of the Chinese words *hsià* (下) or *shīh* (湿) would have realized that the pronunciations resembled those in the English words *shaw* and *sure* respectively. Studies that transliterated English values into non-English alphabets would have encountered similar issues. The Taylor and Taylor (1962, Exp. 3) study, for example, transliterated voiced and unvoiced stops ([b], [d], [g], etc.) into the Korean alphabet; however, the reading of target consonants as voiced or unvoiced in Korean writing is influenced by the

phonetic environment (i.e., by the sounds occurrence word-initially or between vowels).

A possible confound in such experiments is the effect of orthography itself (cp. Koriat &

Levy, 1977). Because the observed effect in these experiments tends to be small, letter

shape could represent a confound even if the influence was small.

Due to the unconstrained nature of the task, the cognitive processes associated

with the task are also unclear. Weiss (1964b), in his discussion of studies using stimuli

that lack a clear frame of reference, claims that null findings in such studies are often the

result of participants' use of multiple strategies to perform the task. Participants in his

experiment, for example, when asked to make magnitude judgments regarding a nonce

word, would sometimes consider whether the word resembled baby talk or whether it

resembled a familiar Latin root. Taylor (1967), in her discussion of Weiss (1966),

considers three heuristics that participants may employ in L1-word to foreign-word

matching experiments: (1) word length, (2) sound correspondences between L1 and

foreign words, and (3) imitative features. Her brief analysis of the Weiss study suggests

that participants do not make much use of L1-to-foreign-word sound correspondences.

Word-length is particularly likely to present an important cue due to the fact that word

length roughly corresponds to frequency of use (and by extension, the narrowness of a

word's semantic range) in all languages (Zipf, 1935).

In addition to the word-matching paradigm used in the studies listed in Table 5,

researchers have employed a number of other methods to verify the psychological

validity of SS. A number of researchers have used a word production task in which

participants generated words associated with a semantic target (e.g., large size). The

results are then analyzed to determine whether some phonemes appear more often than

would be expected relative to some baseline. Klank, Huang, and Johnson (1971, Exp. 2), for example, compared the generated words to the results of a similar task using Chinese L1 participants' generation of Chinese synonyms. Their study found that similar ratios of specific sounds were used to mark the target semantic contrasts. The study attempted to verify the existence of universal SS across two unrelated languages. In a similar study, Magnus (2001, Exp. 13) asked participants to coin a monosyllabic word based on definitions (e.g., the act of scraping burnt top off of toast). Certain phonemes were strongly preferred. Magnus (2001, Exp. 14) employed a similar production task, asking participants to coin a word based on abstract pictures. She also found some SS patterns in the responses.

The tasks discussed so far are likely to enlist metacognitive strategies and, in some cases, overt reflection on sound-symbolic patterns in language. For this reasons, such strategies may reflect poorly the online cognitive processes that language users employ unconsciously during more naturalistic language tasks. In an attempt to avoid this problem, some researchers have employed word-learning tasks. The items in these experiments are typically divided into one set of words (i.e., the "congruent" items) in which the sound-symbolic patterns are associated with meaning in a manner consistent with the L1 of the participant. For other words (i.e., the "incongruent" items), the meaning association is opposite or unrelated to the word's phonology. Sensitivity to sound-symbolic patterns is then measured by examining the advantage speakers have when learning congruent words.

In one study of this type, Nygaard, Cook, and Namy (2009) taught English-speaking monolinguals Japanese words paired with the correct meaning, opposite

meaning, or a random antonym. Results showed an advantage in terms of both accuracy and response latencies for correct versus random pairings. The researchers hypothesized that the English learners were using some features of sound symbolism that were common to both English and Japanese to bootstrap their learning of unknown words. In a similar study, Langenmayr and Schmitz (1996) taught 249 participants words from Indonesian, Swahili, and a mixed list of languages. They failed to find an advantage for congruent words in their main results, although there was an advantage for these words when they appeared at the top of the study lists. While these studies provide some intriguing findings, the researchers unfortunately fail to identify sound-symbolic components of the linguistic targets in a precise manner. As a result, it is difficult to determine what features of the words (e.g., consonants, vowels, word length, etc.) the participants were using (or in the latter study, were failing to use) to learn the words at above-chance levels.

Bergen (2004) has criticized methodologies that allow conscious reflection since participants can often identify linguistic regularities that are not thought to influence actual cognitive processes (p. 295). To avoid the influence of conscious strategies, Bergen used an experiment examining priming effects similar to those found for compositional morphemes. Morphological priming effects generally differ from semantic and phonological priming in terms of both degree and time course.

In Bergen's experiment which used the morphological priming method (discussed in Drews, 1996; Kemley & Morton, 1982), the effects were differentiated from mere form priming and semantic priming, and were only present for words with well-attested form-meaning correspondences within the lexicon. He showed a prime (the orthographic

representation of a word) for 150ms followed by a 300 ms lapse then a target word shown

for 1000ms or until response. Participants were asked to determine if the target was a real

word. The targets were 50 word pairs that were divided into five categories: (1)

phonestheme (i.e., words sharing phonology and semantics), (2) form (i.e., words sharing

only phonology), (3) meaning (i.e., words sharing only semantics), (4) pseudo-

phonestheme (the prime and target shared a complex onset and a semantic feature, but

there were few words in the Brown Corpus that had this same form-meaning

correspondence), and (5) baseline (the words shared neither form nor meaning). The non-

word targets (50) were created by altering final letters (e.g., *glow* became *glone*). Words

across conditions were matched for both frequency and length, and in the development of

the materials, lexical decisions times reported from the English Lexicon Project were

taken into account.

  The study found that the phonestheme condition was faster than the four other

conditions. In fact, this condition was faster than the meaning and form conditions even

after their priming effects had been summed. Bergen interprets the findings as consistent

with usage-based models since (1) these models posit emergent schemas that do not

require that the relevant linguistic unit be compositional, and (2) they account for the

effects of type and token frequency. He notes that dual route models (e.g., Pinker &

Prince, 1988) are less parsimonious and fail to predict the similarities between

phonestheme and morphological processing. The Bergen study has several limitations.

The within-subject conditions have different target words, which could allow lexical

properties to be confounded with the critical manipulation of the five conditions. For this

reason, the study does not provide solid support for the psychological reality of SS. The

dissertation will now review research, mostly conducted in the last decades, that has focused specifically on the acquisition of sound-symbolic patterns by L1 and L2 learners.

2.7 L1 and L2 Acquisition of Sound Symbolism

While it is possible that some sound-symbolic patterns are innate, crosslinguistic variation would suggest that most, if not all, such patterns are acquired through linguistic input. It should be noted that SS, while constituting a feature appearing in individual words, is, by its very definition, a semantic pattern that occurs throughout some portion of a set of words sharing the same phonological feature. Consequently, acquisition of the pattern would entail a process of induction that would typically be entirely unconscious. Firth (1930/1964) recognized this early on with his reference to phonesthemes as "phonetic habits" (pp. 180-188).

There is evidence that children can make use of SS at a very young age. Peña, Mehler, and Nespor (2011), for example, showed that infants as young as four months old associated high vowels with small size and low vowels with large size. The researchers played a high vowel (/i/ or /e/) or low vowel (/a/ or /o/) as infants viewed a screen displaying a small and large object. Eye tracking data revealed that infants were more likely to attend to the small object when high vowels were played and to the large object when low vowels were played. The vowels also corresponded to the time the infants spent watching the object.

Spector and Maurer (2013) examined toddlers' ($N = 20$, mean age = 34 months) sound-shape associations in an experiment using nonce words (e.g., *kiki*) with the vowel /i/ and nonce words (e.g., *koko*) with the vowel /o/. Consonant values and word length

were kept constant, so as to constitute a control variable. Participants were asked to play

a game in which they pointed to the shape named by the experimenter. Based on prior

research, it was hypothesized that /i/ would be associated with angular shapes and /o/ (a

vowel made with a rounded mouth) would be associated with round shapes. The

participants conformed to the expected pattern at a rate greater than chance ($p = .006$,

one-tailed), choosing round object for /o/ nonce words in 68% of the trials and matching

/i/ with angular shapes in 63% of cases.[30] As the authors mention, the results are open to

divergent theoretical interpretations. It could be that children learn SS based on

distributional biases in the sound-shape correspondences in English. An alternative

interpretation would be that they are sensitive to the iconism that purportedly motivates

the SS (e.g., the rounding of the lips). These two interpretations need not be considered as

either-or alternatives: children may be sensitive to both phonosemantic distributions and

iconism.

These findings suggest that within L1A, SS may play an important role as a

bootstrapping mechanism. Children, faced with the daunting task of pairing phonological

forms with a myriad of possible meanings, may be assisted by the presence of sound-

symbolic patterns that they have acquired from previous learning. Children may also

benefit from recognizable iconic elements in early word learning. Caregivers appear to

intuitively recognize this, based on the prevalence of sound-symbolic words in motherese.

Yoshida (2012, Exp. 1), in an observational study of verbs in motherese, found that both

Japanese and English-speaking caregivers frequently use sound-symbolic words, with

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[30] In previous research, Maurer et al. (2006) have similarly demonstrated that both toddler around 2.5 years of age and adults can associate nonce words with shapes based on sound-symbolic patterns at rates greater than chance ($p < .001$).

English-speakers using more non-conventionalized forms. Sound-symbolic forms are also frequently used in Korean children's literature (An, 2010).

On the other hand, there does seem to be some cross-linguistic variation in the relative prevalence of sound-symbolic words in motherese. S.-B. Bae and Choi (2012), for example, found that Korean caregivers used more sound-symbolic words to children compared to their English or Chinese counterparts. They also found that caregivers used more sound-symbolic words when speaking to children than when speaking to adults. Finally, they found that immigrant caregivers (i.e., those who learned Korean as adults) used less sound-symbolic language when speaking to their children and that their children also used fewer sound-symbolic words when speaking.

Research that has directly examined the role of SS in L1A has generally found a facilitative effect. For example, Imai, Kita, Nagumo, and Okada (2008) found that even young Japanese children (2-3 years of age) could make use of SS to learn words. Yoshida (2012, Exp. 2) demonstrated that both Japanese- and English-speaking children were better able to learn nonce words when these words incorporated sound-symbolic patterns.

Many of the studies reviewed earlier that addressed the psychological reality of SS are also relevant in demonstrating adult L2 learners' sensitivity to sound-symbolic patterns. Even so, it would be worthwhile to investigate some recent studies that have examined the issue with greater methodological precision. Iwasaki, Vinson, and Vigliocco (2007a) found that English speakers with no prior experience of learning Japanese could infer the meanings of Japanese mimetic words describing types of pain. They found that English speakers interpreted reduplicated words very similarly to Japanese speakers in many semantic dimensions (e.g., aching, bothering, continuous, and

affecting wide areas), suggesting the potentially universal effect of reduplication. In contrast, only Japanese speakers were consistently sensitive to voiced-voiceless consonant contrasts (words beginning with voiced consonants are associated with more intense, aching, suppressing, and numbing pain). The study thus suggests that SS can involve both language-specific patterns and more general patterns that are found across different languages.

Another study by the same authors (2007b) also looked at the intuitions of English-L1 speakers who did not know Japanese. Regarding Japanese mimetic words related to laughter and walking, they found that these speakers' intuitions for laughter-related words were similar to those of NSs, whereas their intuitions for walking-related words[31] diverged markedly. As in their study on pain-related words, the study found that English speakers were insensitive to the semantic associations of certain voiced/unvoiced contrasts. In addition to these two studies, some research (e.g., Iwasaki, 2008; Iwasaki, Vinson, & Vigliocco, 2005) has provided descriptive accounts of adult L2A of sound-symbolic words and patterns.

A recent innovation in research examining adult sensitivity to SS in unknown L2 words is the inclusion of neuroimaging within behavioral research. Revill, Namy, Defife, and Nygaard (2014) examined L1-English participants' sensitivity to the SS in words in unknown (and typologically unrelated) languages. The target items used for both the target sound-symbolic word set and the target prosaic (non-sound-symbolic words) word set had already been shown to be effective in previous research using learners from multiple L1s. That is to say, in studies in which participants had to choose from a pair of

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[31] The neurological activation associated with walk-related English mimetic words as opposed to non-mimetic words has been discussed by Osaka (2009).

antonyms (e.g., "Does this nonce word mean *hot* or *cold*?"), the sound-symbolic words had previously been correctly selected by at least 80% of the participants. The prosaic words, on the other hand, had produced no consensus in previous studies. Brain imaging data (fMRI) showed heightened activation in the left superior parietal lobe for sound-symbolic words relative to prosaic words. The authors suggest that this indicates greater employment of cross-modal sensory integration for the sound-symbolic words. Further analysis showed that individual differences in performance in the behavioral task corresponded to brain activation patterns that have been previously shown to be linked to cross-modal integration.

One weakness in the above studies which have been based on existing words is the lack of control of the phonetic features that are responsible for the observed behavioral effects. To gain more control over the experimental targets, many researchers have designed materials that use nonce words that vary only in terms of the phonological dimension of interest (e.g., contrast between voice/unvoiced stops or front/back vowels). Thompson and Estes (2011), in a representative study of this type, conducted two experiments to investigate college students' (both English L1 and other L1 backgrounds) associations of phonemes with magnitude. In Exp. 1 ($N = 47$), they presented a series of novel figures (i.e., "greebles") that appeared in five sizes, along with nonce words that varied in the number of large (a, u, o, m, l, w, b, d, g) and small (i, e, t, k) sounds. To prevent associations between nonce words and existing words, the researchers constructed three CVCVCV (C = consonant, V = vowel) words. The five nonce words shown on each trial contained 6, 4, 3, 2, or 0 "large" phonemes. On each trial, participants saw a *greeble* (appearing in one of the five sizes) and selected the most

suitable nonce word as the "name" for that *greeble*. Results showed that *greeble* size linearly predicted the number of "large" sounding letters ($p < .001$, $\eta^2 = .615$). Exp. 1 provides tentative support for the psychological reality of SS. The effect size is fairly large considering that some nuisance factors are unavoidable in this design (e.g., chance associations between nonce and real words, etc.) The study has a couple of drawbacks associated with earlier research: (1) participants may interpret written nonce words as referring to different phonemes, and (2) the phonetic basis for the SS is not entirely clear.

In Exp. 2 ($N = 19$), Thompson and Estes (2011) used two-syllable CVCV nonce words incorporating phonemes associated with small or large magnitude: the "small" (/p/, /t/, /k/) and "large" (/b/, /d/, /g/) stops and front ("small") and back ("large") vowels (/i/, /e/, and /u/, /o/). All syllables were either "small" (a "small" consonant followed by a "small" vowel) or "large" (a "large" consonant followed by a "large" vowel). Thus, the two-syllable nonce words were either "large" (containing two "large" syllables), medium (containing one "small and one "large" syllable), or "small" (containing two "small" syllables). Participants viewed a small, medium-sized, or large *greeble* (standing next to a human figure of a fixed size) and saw three gray circles which they clicked on to hear one of the three nonce words (i.e., a "small," "medium," or "large" word). They then indicated their choice on an answer sheet. Results indicated that the size of the *greeble* predicted the number of "large" phonemes, $p < .001$, $\eta^2 = .404$. Exp. 2 provides support for the psychological reality of SS. One complicating aspect of the study was the use of a heterogeneous group of participants, a third of whom were NNSs of English, although it should be noted that the authors' post hoc analysis showed no differences between the NSs and NNSs.

In sum, the extensive body of empirical research strongly suggests that SS is psychologically real, although much of the research has methodological limitations. Fortunately, some of the research conducted in the last five years has employed more rigorous designs that have established the psychological reality of sound symbolism for at least some phonetic and semantic areas. Peña et al. (2011), an eye-tracking study involving infants, is particularly convincing. The age of the participants precludes the potentially confounding effects of metacognitive strategies that often taint research using adults. In addition, the finding that children are sensitive to SS even before they have acquired their L1 strongly suggests that SS is based on fundamental learning processes that are common regardless of L1 background and therefore not input-dependent. Attentiveness to SS has also been demonstrated (Spector & Maurer, 2013) in toddlers who are still immersed in the task of fully acquiring the rudiments of their L1, suggesting that SS may serve as an important bootstrapping mechanism in L1A. Careful empirical research using well-designed sets of nonce word (e.g., Thompson & Estes, 2011) indicates that adults remain sensitive to systematic correspondences between phonemes and general semantic categories. The findings are thus supportive of usage-based accounts of language (Beckner et al., 2009) that emphasize remarkable pattern-extraction abilities related to human language acquisition. Recent behavioral research on SS has also put previous linguistic research, which has often relied on researchers' intuitions, on more solid footing. Finally, the recent incorporation of neuroimaging (Revill et al., 2014) is bringing research on SS to its maturity, providing the basis for fruitful cross-disciplinary and theory-driven.

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CHAPTER 3: OVERVIEW OF THE CURRENT STUDY

3.1 Purpose of the Study

Having reviewed the research on the SPH and SS, the dissertation will now turn

to the intersection of these two research areas. Based on the research discussed thus far,

the dissertation will predict SP effects for the acquisition of native-like intuitions

regarding sound-symbolic patterns. It must be noted that the use of the word *patterns* is

important in formulating the key area of concern for the current study. The dissertation

will not predict that NNSs will be unable to acquire certain lexical items that are

associated with SS; rather, it will predict adult NNSs' reduced sensitivity to the abstract

patterns that reoccur within sound-symbolic words. An SP for this area of L2A is

predicted on the following grounds:

The entrenchment of an L1 is thought to coincide with a reduced ability to form

nativelike L2 phonological categories (MacWhinney, 2005). Moreover, late L2 learners

have been shown to have a reduced ability to accurately discriminate L2 phonological

categories (Abrahamsson, 2012; Abrahamsson & Hyltenstam, 2008). When these

categories form the basis for sound-symbolic patterns, L2 learners would therefore be

expected to have a reduced ability to acquire the patterns.[32]

At a more general level, L1-attuned processing strategies may hinder acquisition

of SS. As Malkiel (1990)points out, sound-symbolic patterns may be closely associated

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[32] It may be argued that when it comes to SS, speakers may retain sensitivity to phonetic variation even when it is not phonemic in their own L1. However, Taylor and Taylor (1962), in an examination of participants' magnitude-related associations for six consonants and three vowels, found a lack of interaction between consonants and vowels. Since vowels typically undergo lengthening and other changes based on features of adjacent consonants, their results suggest that participants lacked sensitivity to nonphonemic variation.

with specific word classes in a language (p. 180). Providing an insightful example of this, Malkiel discusses the consonant + l pattern in English, and shows that words in the noun class (e.g., *eagle*) tend to depict matter-of-fact items, whereas the verbs tend to report a bizarre state of affairs (e.g., *straddle*). The example suggests the existence of subtle interactions between morphosyntax and SS. This sort of complex pattern is presumably language-specific and is therefore likely to present a challenge to adult L2 learners. Previous research has, after all, demonstrated that late L2 learners will often display a tendency to focus attention on specific linguistic elements based on L1 patterns (MacWhinney, 1989, 1992, 1997; Slobin, 1996, 2004). For example, speakers of English, which has a relatively inflexible SVO patterns, will rely heavily on word order as a cue, whereas speakers of Italian, which has a more flexible word order, will rely more on case-marking (MacWhinney & Bates, 1984). It may therefore be predicted that Korean learners, who are used to encountering systematic SS primarily within words with specific syntactic roles (e.g., reduplicative adverbs, etc.) will be less sensitive to SS occurring in English verbs and nouns. In other words, it is likely that they will have non-optimal processing strategies that degrade their ability to induce sound-symbolic regularities from the input.

The SPH literature also suggests that adult L2 learners will be affected by reduced implicit learning capacities. According to DeKeyser and Larson-Hall (2005), because children tend to learn implicitly and adults explicitly, "adults show an initial advantage because of the shortcuts provided by the explicit learning of structure, but falter in those areas in which explicit learning is ineffective, that is, where rules are too complex or probabilistic in nature to be apprehended fully with explicit rules." Children, while

unable to make full use of explicit learning mechanisms, are said to "eventually reach full native speaker competence through long-term implicit learning from massive input" (p. 103).

Adult L2 learners are also likely to be affected by negative transfer. When sound-symbolic patterns in the L1 are the inverse of those in the L2, transfer may hinder the formation of appropriate L2 categories. Because SS has not, to my knowledge, been investigated in the literature on transfer, it is difficult to make precise predictions on the potential effects of L1 transfer in this area.

Adult L2 learners may also be negatively affected by overly coarse-grained lexical representations. Jiang (2000) has proposed an L2 lexical model according to which entries often lack full morphological specifications. If sound-symbolic patterns are cognitively instantiated much the same way as regular morphological patterns, the model would suggest that adult L2 learners develop lexical representations that lack some of the sound-symbolic information that is characteristic of NS lexical representations.

In sum, the present study predicts SP effects for the L2 acquisition of SS patterns. SS was selected as a target feature due to its probabilistic nature. Consequently, SS would appear to be an ideal area to test for potential SPE, as the statistical form-meaning mappings of SS render L2A of these patterns vulnerable to being affected by the previously elucidated factors (L1 entrenchment, L1-attuned processing strategies, reduced implicit learning capacities, negative transfer, and overly coarse-grained lexical representations). The present research aimed to give focus to the effects of reduced implicit learning abilities in older learners as a potential underlying variable for SPE, which would be demonstrated by differential SS sensitivities by early and late learners.

The study also investigated the potential role of implicit aptitude on the ultimate attainment of SS. The present research hypothesized that L2 learners with aptitudes associated with subconscious pattern abstraction would eventually be better capable of acquiring certain linguistic features requiring implicit knowledge compared to their counterparts of similar AOs (Woltz, 2003). This relationship could be an important variable for understanding why some adults acquire such native-like L2 levels and other adults have more trouble doing so despite similar AOs, immersion settings, and/or relationships between first and second languages for the respective linguistic domains.

3.2 Research Questions and Hypotheses

The current research aimed to investigate the phenomena of maturational declines in the areas of SS, with a complimentary study of how different language-learning aptitudes interact with the SS sensitivities of the NNSs.

Hypotheses 1 and 2 predicted the differences in sensitivities for two different SS areas (magnitude SS and phonesthemic SS) amongst NNSs of varying AOs: an early learner group (AO 3-9) and two late learner groups (AO 10-16; 17+). The groupings were motivated by former research by Johnson & Newport (1989)[33] that found age-related declines (the "offset", in SPH terms) in learners with first significant L2 exposure during puberty. For both SS areas, the experiments aimed to test the learners' preferences for English-congruent sound-meaning associations. Magnitude SS sensitivities of the NNS groups were measured by the extent to which they had English NS intuitions when

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[33] For Johnson and Newport (1989), AoA participants were divided into an early arrival group (AoA < 15) and a late arrival group (AoA > 17). Linear declines were observed in the AoA-proficiency function among early arrivals that arrived in the USA after age 7, but this pattern did not continue in the late arrival group.

associating vowel sounds to motions of large or small magnitude. Phonesthemic SS sensitivities of the NNS groups were measured by the extent to which the English-congruent SS facilitated their learning of new words.

The areas of magnitude and phonesthemic SS were tested for evidence of SP effects, and were therefore observed for certain characteristics that are considered elements of a SP: native-like performance of younger NNSs, a gradual decline in L2 proficiency as a function of age, and a discontinuity when the downward slope becomes less steep or "flattens" (DeKeyser, 2013; DeKeyser, Alfi-Shabtay, & Ravid, 2010; Granena & Long, 2013a).

The specific research questions to be addressed in the present study are as follows:

Research Question 1: What is the pattern of group difference amongst NNSs with varying AOs with respect to their sensitivities to English SS related to magnitude when mapping unknown words to meaning?

- Hypothesis 1a: The late L2 learners will demonstrate less sensitivity to English SS related to magnitude than NSs when mapping unknown words to meaning.

- Hypothesis 1b: The late L2 learners will demonstrate less sensitivity to English SS related to magnitude than early learners when mapping unknown words to meaning.

- Hypothesis 1c: The two late L2 learner groups will demonstrate similar sensitivities to English SS related to magnitude when mapping unknown words to meaning.

- Hypothesis 1d: The early L2 learners will demonstrate sensitivity to English SS

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related to magnitude similar to NSs when mapping unknown words to meaning.

Research Question 2: What is the pattern of group difference amongst NNSs with respect to the degree to which they utilize phonesthemes to bootstrap their learning of unknown SS nonce words?

- Hypothesis 2a: The late L2 learners will utilize phonesthemes to a lesser degree to bootstrap their learning of unknown SS nonce words compared to NSs.

- Hypothesis 2b: The late L2 learners will utilize phonesthemes to a lesser degree to bootstrap their learning of unknown SS nonce words compared to early learners.

- Hypothesis 2c: The two late L2 learner groups will utilize phonesthemes to a similar degree when bootstrapping their learning of unknown SS nonce words.

- Hypothesis 2d: The early L2 learners will utilize phonesthemes to a similar degree as NSs to bootstrap their learning of unknown SS nonce words. The language-learning aptitudes of the early learner group and the two late

The language-learning aptitude of the early learner group and the two late learner groups was measured by the LLAMA battery of tests (Meara, 2005). The subcomponents of the LLAMA test (LLAMA B, E, and F) have been found to be more relevant to explicit learning, and will therefore be referred to as "explicit" language aptitudes. The LLAMA D subcomponent of the LLAMA test has been found to be more relevant to implicit learning, and will therefore be referred to as an "implicit" language aptitude. This prediction is supported by the study of Forsberg Lundell and Sandgren (2013), which found that only the LLAMA D predicted collocation production (an area of

language which, like sound symbolism, is purported to be associated primarily with implicit learning).

Research Question 3: What are implicit and explicit language aptitudes' relationships with the magnitude and phonesthemic SS sensitivities of the NNS groups.

- Hypothesis 3a: The two late L2 learners will demonstrate a significant, positive relationship between implicit language aptitude and magnitude SS sensitivities.

- Hypothesis 3b: The two late L2 learners will demonstrate a significant, positive relationship between implicit language aptitude and phonesthemic SS sensitivities.

- Hypothesis 3c: The two late L2 learners will not demonstrate a relationship between explicit language aptitude and magnitude SS sensitivities.

- Hypothesis 3d: The two late L2 learners will not demonstrate a relationship between explicit language aptitude and phonesthemic SS sensitivities.

- Hypothesis 3e: The early L2 learners will not demonstrate a relationship between implicit language aptitude and magnitude SS sensitivities.

- Hypothesis 3f: The early L2 learners will not demonstrate a relationship between implicit language aptitude and phonesthemic SS sensitivities.

- Hypothesis 3g: The early L2 learners will not demonstrate a relationship between explicit language aptitude and magnitude SS sensitivities. explicit language aptitude and magnitude SS sensitivities.

- Hypothesis 3h: The early L2 learners will not demonstrate a relationship between explicit language aptitude and magnitude SS sensitivities.

3.3 Outline of the Design of the Study

This dissertation involves three experiments, including two forced-choice tasks and a word-learning task. The first experiment used a forced-choice task. The participants were instructed to listen to a sentence containing nonce words and then to choose the video clip that matched the given word from the two video clips demonstrating a physical movement (big or small). The target feature was magnitude SS which suggests a direct correlation between vowel contrast (e.g., /a/ vs. /i/) and size contrast (e.g., small vs. big). The choice of this target feature was based on the fact that the cross-linguistically widespread magnitude associations of high front vowels with smallness and low back vowels with largeness are reversed in Korean (Kwon, 2015; J.-S. Lee, 1992; Martin, 1962). The experiment examined whether L1-Korean NNSs can use L2 SS even when the SS patterns are dissimilar to those in their L1 SS system.

The second experiment tested the same construct as the first experiment, but with a slightly altered study design. A single video clip was associated with two nonce words containing magnitude-vowels SS that were embedded in English sentences. The participants heard two sentences containing the contrasting vowel that were played sequentially and chose the sentence that matched the given stimulus.

Both experiment 1 and experiment 2 predicted that early L2 learners would perform similarly to NSs on the forced-choice task, whereas the late L2 learner groups would have reduced magnitude SS sensitivities compared to early L2 learners.

Experiment 3 used a word-learning task to examine NNSs' intuitions regarding English phonesthemes. The participants learned nonce words for 30 minutes. Half of the words had form-meaning correspondences consistent with English phonesthemes, whereas the other half had inconsistent form-meaning correspondences. After this

learning phase, participants were tested on their retention of the learned words. In English, phonestheme words, such as the tendency of words beginning with *gl-* to be associated with meanings related to light or vision (e.g., *glow*, *gleam*, *glare*, etc.), are psychologically real according to several behavioral and corpus based studies in SS literature. Magnus (2000) has found that participants chose a word for a given definition, an average of 80% of the constructed definitions were from a limited range of semantically related domains. As an example, the word *gurfus* seemed overwhelmingly to evoke definitions concerning stupidity and anger.

The current study focused on the target feature of phonesthemes as they are probabilistic in nature and containing features not readily amenable to instruction. Therefore, it may pose a difficulty for NNSs whose L1s don't have a corresponding counterpart. It was thus predicted that early L2 learners would perform like NSs on the word-learning task, and the late L2 learner groups would be distinctly nonnative-like.

The above-mentioned two target features tested in all three tasks were predicted to demonstrate age effects, as the tested language areas are known to be difficult to learn explicitly. Older learners of post-puberty ages have been proposed to experience strong maturational declines in statistical learning ability due to attenuated implicit learning capabilities. (DeKeyser, 2000; Janacsek, Fiser, & Nemeth, 2012)

Lastly, the dissertation investigated the LLAMA test scores and their correlation with scores from the three experiments. It was predicted that aptitude for implicit language learning would have high correlations only for late learners, and not early learners and NSs.

DeKeyser (1995) proposed that, compared to explicit-deductive learning approaches, implicit-inductive learning would be ideal for the learning of "fuzzy" language patterns with inconsistent form-meaning mappings. Therefore, the current research proposes that adult learners' aptitudes for learning implicitly would have a facilitative effect on the acquisition of SS patterns. Younger learners and NSs, on the other hand, would have first significant language exposure at an age when they are at a developmental "peak" of acquiring, such prototypicality patterns; the study theorizes that the UA of these learners would be independent of individual language-learning aptitudes.

Prior to the end of the SP, learners will generally have strong implicit learning abilities. Hence, individual differences in aptitude (to include aptitude for implicit learning) will not have a sizable effect on learning outcomes. Post-SP learners, on the other hand, will have reduced implicit learning abilities; individual differences in terms of aptitude, particularly those elements of aptitude relevant for the learning of SS (i.e., implicit aptitude), will have a stronger association with successful outcomes. This prediction is supported by the study of (Forsberg Lundell & Sandgren, 2013), which found that the LLAMA D test (among the LLAMA subtests) predicted the accuracy of collocation production (an area of language which, like sound symbolism, is purported to be associated primarily with implicit learning) for older learners.

The participants were adult learners of English and English native speakers. They were recruited from universities and churches in Washington D.C. and nearby suburban and metropolitan areas of Maryland and Virginia. All participants were compensated with $30 for their time after testing. The participants were screened to verify that they were 18 years old or older at time of testing, but no older than age 50 to reduce the likelihood of

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lower performance by the older group due to general age-related cognitive decline. Additionally, the NNS English learners had to be NSs of Korean who were exposed solely to their native language from birth until their age of first meaningful exposure to English (AO). AO was calculated once the learner had a high quality and substantial quantity of L2 exposure (i.e., once fully immersed in an English-speaking environment), so being taught rudimentary English during the NNSs' primary and secondary school years in Korea was not counted. Furthermore, the participants with the latest AOs above 18 were verified not to have majored in English when attending a Korean college. The participants were separated equally ($n = 20$) into four groups for a total of 80 participants: (1) a group of adult NSs of English, (2) a group of Korean NNSs with an AO between 3 to 9, (3) a group of Korean NNSs with an AO between 10 to 16, and (4) a group of Korean NNSs with an AO of 17 or higher. The AOs of the NNSs ranged from 3 to 25. The last prerequisite for the participant group was that NNSs had to have a length of residence (LOR) of 10 years or above[34] (ranging from 13 to 30 years).

In the early learner group, 58% of the participants were female and 42% were male ($n = 20$). In the late learner groups, 43% were female and 57% were male ($n = 40$). For the NSs, 62% were male and 38% were female ($n = 20$). All participants had received higher education in the form of an undergraduate and/or graduate degree at a U.S. college or university. Although many were in the process of completing a college degree, slightly over a fourth of the participants were working in a variety of different careers, such as government, entrepreneurial, and/or private company positions. The majority had immigrated to the U.S. with their families, many had come to the U.S. due to marriage,

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[34] DeKeyser (2000) recommends sampling NNSs who have had sufficient opportunity to acquire the target language and he therefore recommends that the selected NNSs have resided in the target-language environment for at least ten years to attain their peak levels of L2 proficiency.

and a minority had immigrated alone. In the questionnaire (see Appendix E), many

participants indicated that they had immigrated. for educational purposes. All NNSs were

born to Korean-speaking parents who had minimal English proficiency and did not use

English at home. All NS controls were born in the U.S., had not spent significant time

living in other countries, and were carefully screened so that none had been previously

exposed to Korean through their interpersonal relationships or educational background.

Table 6 illustrates the participants' background information.

Table 6.
Participants' Background Information

	Age of Onset		Age at Testing		Length of Residence	
	M	*Range*	*M*	*Range*	*M*	*Range*
Control (*N* = 20)			28.37 (6.13)	20-38		
Early NNS1 (*N* = 20)	5.74 (1.49)	3-9	23.84 (5.81)	18-37	18.17 (5.03)	12 to 30
Late NNS2 (*N*=20)	13.05 (2.06)	10-16	30. 05 (4.91)	22-38	16.95 (4.63)	13 to 20
Late NNS3 (*N* = 20)	20.13 (2.47)	17-25	35.72 (4.86)	30-46	14.96 (3.67)	12 to 25

Note. Standard deviations appear between parentheses.

As indicated in Table 6, the average AO was approximately 6 for the early learner

group, 13 for the first late learner group, and 20 for the latest AO group. The AOs of all

NNS participants ranged from 3 to 25. For age at testing, the latest AO group was on

average older than other groups at roughly 36 years of age, followed by the first late

learner group at approximately 30 years of age and the native controls at slightly over 28

years of age. The early L2 learner group had the lowest age at testing overall at

approximately 24 years of age. The youngest participant was 18, as 18 and over was defined as an adulthood age range and acceptable for testing. The oldest participant was 46, as the cutoff for the participants was 50 to prevent potentially reduced cognitive abilities in older learners that could confound results. In terms of LOR, the prerequisite was an LOR of at least 10 years, and during participant selection the minimum LOR found was 12 years with a maximum of 30 years. The average LOR of the early L2 learner group was slightly over 18 years, nearly 17 years for the first late learner group, and almost 15 years for the latest AO group.

Regarding self-rated English proficiency of the NNS groups on a 10-point scale, the early learner group had the highest number of points ($M = 8.02$, $SD = 1.25$), whereas the late NNS2 and late NNS3 learner groups had lower ratings that were comparable to each other ($M = 6.89$, $SD = 1.52$, $M = 6.11$, $SD = 1.41$, respectively). Concerning the self-reported daily use of English expressed as percentages, early learners used 63.84 % ($SD = 4.02$), late NNS2 used 57.16 % ($SD = 6.34$), and late NNS3 used 46.42 % ($SD = 13.12$).

CHAPTER 4: EXPERIMENT 1
Perception of Magnitude Sound Symbolism
(Magnitude SS: One Target Word, Two Videos)

When selecting a suitable area to test for speakers' knowledge of SS, one potential problem is the precise identification of the general semantic area that is associated with a given pattern. For example, SS that appears to be associated with color could turn out, upon closer examination, to be associated with a more abstract category such as intensity. For this reason, the semantic area of magnitude, as a target area for experimentation, offers several advantages. First, magnitude would appear to be a salient category of meaning, judging from its tendency to be explicitly marked cross-linguistically. Many languages have diminutives and/or augmentatives that are quite productive across one or more grammatical classes. In a considerable number of languages, size is associated with SS symbolism specifically. In Ultan (1978)'s sample, 27.3% of the languages were said to have size SS. Moreover, it has been argued that a heightened attention to magnitude is highly adaptive, and that this semantic dimension is highly salient even to preverbal infants (Lourenco & Longo, 2011). In short, the high cross-linguistic occurrence and the psychological plausibility of the semantic distinction would suggest that magnitude may represent a common category within SS systems. In addition, the linguistic category of magnitude often serves a prominent role in language as a result of being extended to related categories such as grammatical gender or the SS used in male and female names (cp. Pitcher et al., 2013).

The first experiment therefore examined the intuitions of English NSs and L1-Korean NNSs in regards to the association between specific vowels and magnitude. The

participants were asked to match a nonce word with a visual portrayal of a physical action in a forced-choice task.

As noted previously, Korean SS in this semantic area is somewhat anomalous when viewed from a cross-linguistic perspective. The first experiment exploited this difference in order to determine whether NNSs can use L2 SS even when the sound-symbolic patterns are dissimilar to those in their L1 SS system.

4.1 Method

4.1.1 Materials

The experiment examined participants' intuitions regarding five vowel contrasts. The contrasts involved a vowel considered "light" in the Korean SS system (appearing on the left-hand side of Table 8) contrasted with a vowel considered "heavy" in the Korean SS system. The targeted SS vowel contrasts that were used in the Exp. 1 are shown in Table 7.

Table 7.

Targeted SS Vowel Contrasts in the Experiment 1

Contrast	Vowel A	Vowel B	English Association	Korean Association
1	/a/	/ə/	>	<
2	/a/	/u/	>	<
3	/a/	/e/	>	<
4	/æ/	/i/	>	<
5	/o/	/u/	>	<

Previous theoretical analysis of the Korean and English SS systems and piloting data suggest that English speakers will associate the Column A vowels with larger things

or actions relative to the Column B items. Korean NSs, on the other hand, should be inclined to associate Column B items with larger size. However, some Korean NNSs may have been able to switch to English preferences when using English. If this is the case, SS associations are language-specific, and learners were able to inhibit their L1 associations when using an L2. It was hypothesized that early-AO learners can acquire a new SS system and would therefore have associations similar to those of NSs when they encounter unknown words embedded within an English sentence. Late-AO learners, on the other hand, were assumed to lack this ability.

For each of the five target contrasts, 10 items were developed for Vowel A and 10 items for Vowel B (see Appendix A). These were arranged in two blocks so that each participant received five Vowel A and five Vowel B items, with the items appearing equally in the experimental materials. In other words, 100 nonce words were created, but each participant was only exposed to half of these. The nonce words, all verbs, all followed a CVC (consonant-vowel-consonant) pattern. The choice of this pattern and verbs was based on the fact that English sound-symbolic patterns often appear in short verbs (as well as with nouns). It was assumed that NSs (and perhaps some advanced NNSs) would be more sensitive to the SS in newly encountered words if these words have the same phonological structure as existing English sound-symbolic words and if these words occur in the parts of speech more commonly associated with SS.

The nonce words were developed using the sounds /m/, /p/, /b/, /f/, /v/, /θ/, /ð/, /n/, /t/, /d/, /s/, /z/, /l/, /tʃ/, /dʒ/, /ʃ/, /ʒ/, /k/, and /g/ occurring as both onset and coda. Words were constructed so that they did not sound similar to well-known existing words in English.

A PowerPoint was created with slides set to advance automatically. The PowerPoint screen was split into two halves. On each half, a video file showed a human-like robot performing a similar action. The files were created using animation developed through 3D motion capture technology[35] in a university animation studio. Reflective markers are attached to the limbs, torso, and head of the human model so that the actor's movements could be captured by high speed visible-light cameras. This format was chosen over that of the videos used in the pilots, which showed the actions of real people. It was more difficult than expected to purely capture movements of different magnitude with the original video as the actors often had different facial expressions or extraneous movements of the limbs irrelevant to demonstrations of magnitude.

On the PowerPoint, one slide showed an action with exaggerated motions (e.g., a robot grabbing and pulling an invisible rope with large movements), while the other slide showed an action with more constrained motions. The letter "L" appeared at the top of the left side of the screen, and the letter "R" appeared at the top of the right side of the screen. When the slide began, the videos appeared on the left and right side of the screen. At the same time, a nonce verb (e.g., /bav/) was heard embedded within an English sentence (e.g., "The robot is /bav/-ing."). The audio was produced using an audio file in the WAV format embedded within the timed PowerPoint slide. Depending on block assignments used for counter-balancing, participants heard a sentence that corresponds to either the "large" (i.e., exaggerated) movements or the "small" (i.e., constrained) movements. For example, half the participants, instead of hearing the nonce word /bav/,

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[35] ARENA 3D motion capture software and 12 infrared cameras were used to record the movements of the robot. This software is often used in video game, biomechanics, and animated film in order to capture naturalistic movements of the human body.

which contained the vowel /a/ (associated with large magnitude in English SS), heard the nonce word /bəv/, which contained the vowel /ə/ (associated with small magnitude in English SS). Figure 3 shows a screenshot of an example of test item used for Experiment 1.
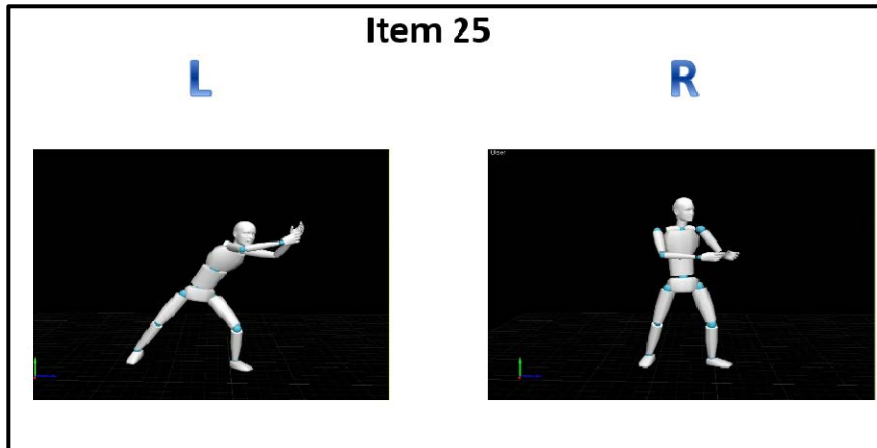
Figure 3. Screenshot of an example of test item, /bav/, where the L2-congruent response of a large magnitude motion is the left "L."

4.1.2 Procedure

Participants were individually administered a computerized forced-choice task. Each participant was randomly assigned one of the sets (block A or B). Participants viewed the PowerPoint slides. The PowerPoint presentation began with a set of directions (Appendix F) and a sample item. In addition, participants were asked to practice responding to one item. Bilingual participants heard the directions in their dominant language.

For the pilot, a microphone connected to a recording device recorded the participants' responses. Participants were instructed to say "left" if they felt the sentence

corresponded to the video on the left, and "right" if the sentence corresponded more closely to the video on the right. However, the actual experiments had the participants click on the left and right arrow keys for the sake of simplicity. To help match responses with items after conclusion of the experiment, the audio for the PowerPoint was played through external speakers. In this way, both the original sentence from the PowerPoint and the participant's response to the question were recorded together. Because the timing of the slides in the PowerPoint were fixed and the items appeared in a fixed order, there was no risk of being unable to match items with responses during the analysis.

To control for possible preference for either left-hand or right-hand items, the screen placement of items (i.e., large magnitude actions on the left and small magnitude actions on the right, or vice versa) alternated randomly and an equal number of each item type appeared in each position. To dissuade participants from focusing excessively on the dimension of magnitude, 20 distractor items were included. On these slides, the two motions differed along a different semantic contrast that is unrelated to magnitude.

Because there were 50 items (which will each be completed in 8 seconds), the total time for the Exp.1 was 10 minutes (2 to 3 minutes for the introduction and 7 minutes for the items). Participants required a few attempts to become accustomed to the task, so the first two items (following the example item in the introduction) were distractor items. The final item was also a distractor item. The remaining distractors were scattered randomly throughout the PowerPoint presentation. The sequencing of the task is shown in Table 8.

Table 8.

Sequencing of Forced-Choice Task (Exp.1).

Phases	Time
Introduction	3 mins.
PowerPoint Slide Presentation for Each Item	
Participant views both videos running simultaneously and hears sentence one time.	4 seconds
Participant responds by saying "left" or "right."	4 seconds
	8 seconds (each item)
	50 items (total items) x 8 seconds = 7 mins.
	Total: 10 mins.

4.2 Results

Experiment 1 was out of 50 points, with each nonce word item being scored as "1" if the response of the test subject was English congruent and "0" for a non-congruent answer. As a measure of participants' sensitivity to English magnitude SS concept, the numbers of correct responses were calculated. English-congruent responses were scored as "1" and incongruent responses scored as "0." According to the Shapiro-Wilk test, Experiment 1 scores were found to be normally distributed ($p > .05$). Table 9 shows the average performance of all groups for Experiment 1.

Table 9.

Group Mean and Mean Percentage Scores on Experiment 1

Group	Experiment 1			
	M	*M%*	*SD*	95% CI
Control (*n* = 20)	37.85	76	4.92	35.5-40.1
NNS1 (AO 3-9) (*n* = 20)	30.65	61	5.53	28.1-33.3
NNS2 (AO 10-16) (*n* = 20)	22.10	44	6.50	19.1-25.1
NNS3 (AO 17+) (*n* = 20)	20.25	40	5.49	19.8-23.2

Note. *n* = sample size, *M* = average score, *M%* = average percentage score, *SD* = standard deviation, 95% CI = 95% Confidence Interval

As shown in Table 9, the NS control group had a relatively higher score compared to the other groups with a mean percentage scores of approximately 76% (*M* = 37.85) and the lowest standard deviation across all four groups (*SD* = 4.92). The early NNS1 group (AO 3-9) had an average test score of roughly 61% on Experiment 1 (*M* = 30.65, *SD* = 5.53). The late NNS2 group (AO 10-16) had lower mean scores (*M* = 22.10, *SD* = 6.5) at a mean percentage score of about 44% on the Experiment 1 task with the highest levels of inter-individual variability. The late NNS3 group demonstrated the weakest levels of magnitude SS sensitivities across the four experimental groups (*M* = 20.25, *SD* = 5.49) with an average performance of 40% on Experiment 1. Interestingly, variability in magnitude SS intuition did not vary significantly across NNS groups. Figure 4 illustrates

the average performance among experimental groups.
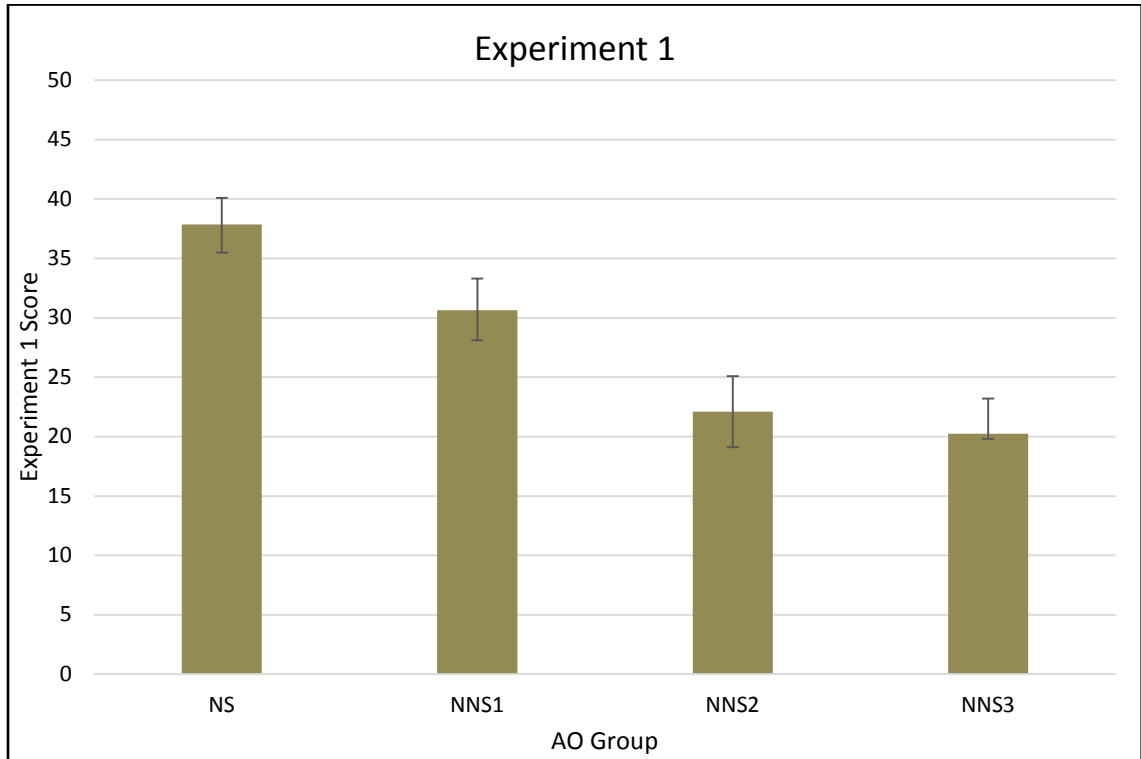
Figure 4. Group average performance for Experiment 1.

As can be seen in Figure 4, the average performance of the experimental groups imply that NSs had the highest levels of magnitude SS pattern intuition when forming assumptions about new words, while NNSs had lower demonstrations of magnitude SS knowledge. More specifically, NNSs that had significant exposure to English past childhood (AO 10-16; AO 17+) demonstrated levels of magnitude SS knowledge that was below chance levels. The similarity between the two late AO groups' average Experiment 1 test scores suggests that NNSs with AOs around adolescence and early adulthood had comparable levels of magnitude SS knowledge when making intuitions

about the meaning of unknown lexical items.

The Levene's test was not significant ($p > .05$), signifying that the assumption of homogeneity of variance was met and the data can be assumed to be normally distributed. A one-way ANOVA test revealed that there was a significant effect of AO on SS acquisition at the $p < .05$ level [$F(3, 76) = 37.29$, $p < .0001$]. These results suggest that the age a language learner is first extensively exposed to the English L2 does influence later demonstrations of English-congruent magnitude SS intuitions as measured by the Experiment 1 task. Post-hoc comparisons using the Scheffé test revealed a significant difference between all group combinations ($p < .05$). The only exception was between the late NNS2 ($M = 20.80$, $SD = 6.95$; AO 10-16) and the NNS3 ($M = 19.70$, $SD = 8.31$; AO 17+) combination that did not significantly differ ($p = .97$, 95% CI [-5.2, 7.4]). These results suggest that the two late NNS groups performed similarly while failing to demonstrate native-like levels on the tested SS knowledge. The Scheffé post-hoc comparisons shows that the NS group was significantly different from the NNS1 (AO 3-9) group ($p = .017$), suggesting that early child learners of English had non-native intuitions of magnitude-related SS. In addition, the early NNS1 group (AO 3-9) was found to have significantly different levels of SS knowledge compared to the late NNS2 (AO 10-16) and late NNS3 (AO 17+) group when making intuitions about the magnitude-related semantics of novel lexical items ($p < .001$ for both group comparisons). The effect size between the NS control group and the early NNS1 (AO 3-9) group suggests moderate to high effects (Cohen's $d = 0.6$) according to conventions outlined by Cohen (1988), whereas the effect size between the early NNS1 and late NNS2 (AO 10-16) groups was even larger ($d = 1.7$). On the other hand, the effect size between the late NNS2 and late

NNS3 (AO 17+) was relatively small compared the other effect sizes between adjacent test groups ($d = 0.1$).

4.3 Discussion

Experiment 1 results were consistent with Hypothesis 1a, which predicted that the two late L2 learners (AO 10-16, 17+) would demonstrate less sensitivity to English SS related to magnitude than NS controls and early L2 learners when forming assumptions about unknown words. The results supported this hypothesis, with the two late learner groups scoring lower than the native controls and early NNS1 learners (AO 3-9) overall, in addition to providing evidence of statistically significant group differences between late learners and NSs with respect to magnitude SS intuitions. This suggests that NNS with an AO beyond the age of 10 had a reduced ability to acquire magnitude SS patterns and that these NNSs are unlikely to score at native-like levels.

The results show that L2 learners with later AOs scored significantly lower than NS and early L2 learners; this suggests that the ability to acquire L2 magnitude SS intuition declines with increasing maturation. One of the possible explanations for the late L2 learners' lack of sensitivity to this target feature is the attenuation of implicit abilities in adults (DeKeyser, 2000). These maturational declines in implicit knowledge are hypothesized to hinder the acquisition of linguistic items ideally acquired through statistical learning of inconsistent form-meaning mappings. More specifically, linguistic items that are probabilistic in nature often cause trouble for older learners, who tend to end up with distinctly nonnative sensitivities to these language areas (e.g., DeKeyser, 2000; DeKeyser et al., 2010). SLA research has found that adults are still capable of

implicit learning to a certain degree (Doughty, 2003; Long, 2014; J. N. Williams, 2009).

However, adult L2 learners have been found to have trouble recognizing cues of

particularly low salience, causing these never to go through the necessary process of

"implicit tallying" for L2-congruent consolidation and recognition (Ellis, 2002). Sound

symbolic patterns in general are theorized to be acquired through implicit learning that

requires gradual tallying and extraction of statistical regularities from experience with

language. This was posited to be an important factor causing difficulty for late L2

learners who have reduced implicit abilities.

Another potential explanation for the attenuated abilities of the late L2 learners is

L1- attuned processing, considering the critical trait of cross-linguistic difference

between the Korean L1 and English L2 in terms of magnitude SS vowel sound contrasts.

If the SS of the L1 and L2 are similar, the language learner can associate L2 vocabulary

with sounds that match most closely auditory and articulatory items of the L1, resulting

in more efficient language learning (MacWhinney, 1989, 1992). The current study tested

the cross-linguistically different magnitude SS patterns of English and Korean. Korean

phonological referents indicate that high front vowels are associated with largeness while

low back vowels are associated with smallness, but in English this is reversed (Kwon,

2015; J.-S. Lee, 1992; Martin, 1962). The study's choice of testing a cross-linguistically

different target language structure was to investigate the possible negative repercussions

for adult L2 learners with an L1 that is not only unhelpful, but possibly intrusive when

learning certain L2 linguistic domains.

Many previous studies in the SS literature studied the universal iconicity features

of SS and their advantage for vocabulary learning in language learners, but fewer studies

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have examined how SS patterns (cross-linguistically shared or language-specific SS) develop in children and adults. Research by Kantartzis (2011) provides some insight into the acquisition of cross-linguistically different SS systems. Her study tested adults' and toddlers' SS intuitions about English language-specific nonce words. Participants with English and Greek L1s were tested. All participants could detect universal SS patterns and, not surprisingly, the Greek-speaking adults demonstrated little to no English language-specific SS intuitions. However, the Greek-speaking toddlers were capable of matching English language-specific SS novel words to the relevant target video. The study suggests that toddlers may possess intuitions for many different SS patterns of various languages even if they are not consistent with the SS of their native language. With age, these young children may lose these additional SS intuitions as they master the L1 until they eventually become exclusively sensitive to SS that is either universal or L1 language-specific (Imai & Kita, 2014; Kantartzis, 2011; Yoshida, 2012). However, the children have a biologically endowed hypersensitivity to possible SS correspondences, but as they mature and master their native language, the sensitivity is pared down until the now adult is mostly receptive to the SS of their L1.

With the same logic in mind, the late learner groups in the present study were less likely to have magnitude SS intuitions compared to the early learners and NS controls because they might have pruned down their SS sensitivities to patterns consistent with the Korean L1 and have lost sensitivity to the cross-linguistically different English L2 magnitude SS. If this interpretation of the data is correct, these results may shed light on developmental changes in sensitivity to SS patterns in bilinguals with varying AOs. This interpretation may illuminate the source of developmental changes in SS

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sensitivities across bilinguals with varying AOs. Further research that includes a wider array of SS pattern semantic categories (e.g., shapes, textures, emotions, etc.) would help corroborate these findings and help confirm the applicability of this theory across the diverse areas of SS.

Hypothesis 1b predicted that the two late L2 learners would demonstrate similar sensitivities to English magnitude-related SS when mapping unknown words to meaning, and this prediction was borne out of the data: the two late L2 learner groups (AO 10-16; 17+) were found to have similar levels of SS knowledge on average at a statistically significant level. As noted earlier, this suggests a discontinuity in the AO-proficiency decline, an important prerequisite necessary for proposing that a language area is in fact influenced by SPE.

Finally, in Hypothesis 1c, it was predicted that the early NNS1 group (AO 3-9) would demonstrate similar sensitivity to English magnitude SS compared to NS controls when mapping unknown words to meaning. The results refuted Hypothesis 1c, such that the early L2 learners did not demonstrate magnitude-related SS intuitions on a level on par with native controls. In other words, early learners had difficulty acquiring SS patterns to native-like levels. The average test performance of the early NNS1 group still demonstrated a certain degree of English-congruent SS intuition, as the results were above chance level (approximately 65% on Experiment 1), but the early NNS1 group could not demonstrate on average native-like test performance despite being significantly exposed to English as children.

Korean sound-symbolic words as a distinct linguistic category are rich in number, and are pervasively used in everyday conversation. Perhaps the early NNS1 group

participants were extensively exposed to Korean SS before learning English, and

therefore the learners' L1 magnitude SS form-meaning mappings negatively affected

their acquisition of a cross-linguistically different SS system in the English L2. The study

by Abrahamsson and Hyltenstam (2009) also observed that incidents of nativelikeness in

early learners are less common than previously assumed, as demonstrated by the failure

of the majority of NNS learners, more specifically all of the late learners and most of the

early learners, to pass a battery of 10 highly complex tasks involving linguistic

performance, representation, and processing. It is important to note that the present study

had similar patterns of results. None of the late learners scored within the NS range on

the Experiment 1 task, but a select few in the early learner group demonstrated native-

like magnitude SS intuitions. Not enough early learners of English scored high enough to

pull the early NNS1 group average to a level on par with NSs. In other words, early

exposure appears to be a prerequisite for attaining native-like levels of magnitude SS

intuitions, but still does not guarantee nativelike attainment of these SS patterns for early

learners of English.

In summary, the early learners had reduced magnitude SS intuitions compared to

NSs; nor did they perform similarly to late learners. In fact, there was a larger effect size

between the early NNS1 group (AO 3-9) and the late NNS2 group (AO 10-16) than

between the NS controls and the early NNS1 group. In a comparable study of L1-L2

interaction during semantic categorization, both early and late learner groups performed

worse than NSs on classical categories due to applying the broader Arabic L1 boundaries

in English L2 cases (Gathercole & Moawad, 2010). Notably, the early learners "were

more successful at discerning the English-relevant boundaries than the late bilinguals in

relation to the…English classical categories," even though they could not demonstrate native-like proficiency. Early learners were acquiring the L2 at childhood ages when the L1's semantic categorization was not yet firmly established, and this simultaneous acquisition of the two languages would have implications for the learning of conceptually close versus conceptually distant categories. Such an L1-L2 interaction observed at early childhood ages would explain why the early NNS1 learners in the present study had levels of magnitude SS intuitions that were lower than NS controls. However, the late learner groups leaned more towards L1-congruent responses when forming assumptions about magnitude-related vowel sounds, suggesting that adult learners of English acquire the L2 from an established L1 linguistic framework and would therefore have less sensitivity to an opposite semantic form-meaning mapping system during L2 exposure.

Another notable observation is that the early learners who scored the highest on Experiment 1 task tended to have the lowest AOs in the group. The sample size ($n = 20$) of the early NNS1 group is too small to make any conclusive inferences about the proportion of learners that scored native-like on the task, but it would be interesting to see the magnitude SS intuitions of learners from an even earlier AO group, perhaps around the AOs of 3 to 6, to test whether they would perform similar to NSs.

In sum, the present research has found evidence for SPE on the acquisition of magnitude SS intuitions. Although the results were not completely consistent with what was hypothesized, the late learner groups did demonstrate attenuated SS intuitions compared to NSs and early learners, and the two late learner groups showed similarities on the relevant task. This is taken to support the existence for SP effects in the linguistic subdomain of English magnitude vowel SS at the approximate age of 9 to 10. Further

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research is needed to ascertain a more precise sense of the root of such AO effects, but the synthesis of previous and current results suggests that the effects of L1-attuned processing and an age-related decline in implicit learning abilities constitute a plausible origin.

CHAPTER 5: EXPERIMENT 2
Perception OF Magnitude Sound Symbolism
(Magnitude SS: One Video, Two Target Words)

The first experiment was designed to examine NNSs' intuitions regarding form-

meaning correspondences that are assumed to exist within the English SS system.

Because Exp. 1 differed in important ways from the pilot, one concern was that the

participants (including the NSs) might display limited sensitivity to the magnitude

contrast. In other words, even if English speakers generally associated the vowel /a/ with

large size and /u/ with small size, these semantic associations might appear more clearly

when words incorporating these vowels were directly contrasted. Exp. 2 therefore

involved a similar design to Exp. 1, but with a single video clip that was to be associated

with two words embedded in English sentences. The two words only differed in terms of

the vowel that was being contrasted.

5.1 Method

5.1.1 Materials

As in Exp. 1, 100 target words were created with only 50 target words shown to

each participant (due to blocking). The items were designed based on the same criteria

used for the items in Exp. 1. However, the items were different to ensure that exposure to

items during Exp. 1 did not affect participants' performance in Exp. 2. As in Exp. 1, a

PowerPoint was created with slides set to advance automatically. In the top portion of the

PowerPoint, a single video file automatically played. Depending on the participant's

block (determined by counterbalancing), the participants viewed an action associated

with large magnitude (e.g., waving vigorously with exaggerated, large movements) or an

action associated with small magnitude (e.g., waving hand close to the body in small movements). To control for possible preference for items associated with the numbers or the position of the numbers, the screen placement of items (i.e., the association of the "large" nonce word with the number "1" or "2") alternated randomly and an equal number of each item type appeared in each position. The actions in the video clip were counterbalanced so that half showed large magnitude motions and half showed small magnitude motions. They appeared in pseudo-random order with the constraint that the same item type (i.e., large or small) could not occur in three consecutive slides. Two blocks were created, each with the target video item in the opposite condition (i.e., large or small). As in Exp. 1, 20 distractor items were included to dissuade participants from becoming exclusively focused on the semantic dimension of magnitude.

5.1.2 Procedure

Individual testing of the computerized forced-choice task was performed. The participant's task was to listen to the two sentences containing nonce words with contrastive vowels sequentially and to choose the video clip that matched the sentence they heard. Each participant was randomly assigned either block A or B of the test sets. The PowerPoint presentation began with a set of directions (Appendix G) and a sample item. In addition, participants were asked to practice responding to one item. Bilingual participants heard the directions in their dominant language.

As the video played, the participant heard (via an embedded audio file) a sentence with one of the target vowels (i.e., a vowel corresponding to large or small magnitude in English SS). For example, the participant heard, "The robot's /so:l/-ing," As this sentence

played, a large number one was shown in a black font (indicating that the sentence is associated with the number "1" on the screen). After this, the large black number "1" on the screen returned to a dull gray color. Then a second sentence (containing the nonce word with the contrasting vowel) played as the number "2" on the screen, shown in a large, black font. For example, the participant heard, "The robot is /su:l/-ing." Both numbers were then shown in black with a question mark between the two numbers. As in Exp. 1, the participant was then asked to make a choice, in this case, responding "one" or "two" to select which nonce word seems to be most suitable to the action performed in the video. Figure 5 shows the screenshot of an example of test item used for Experiment 2.
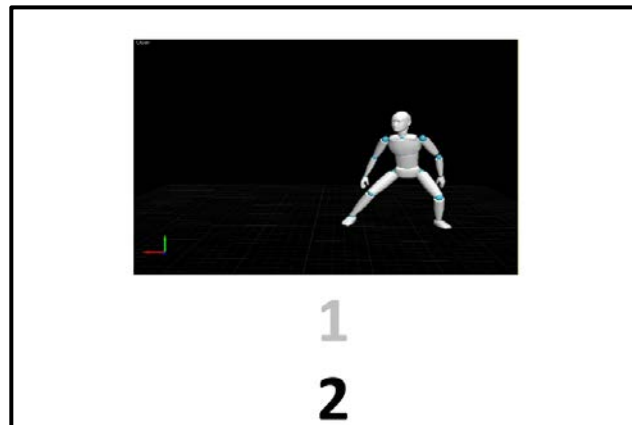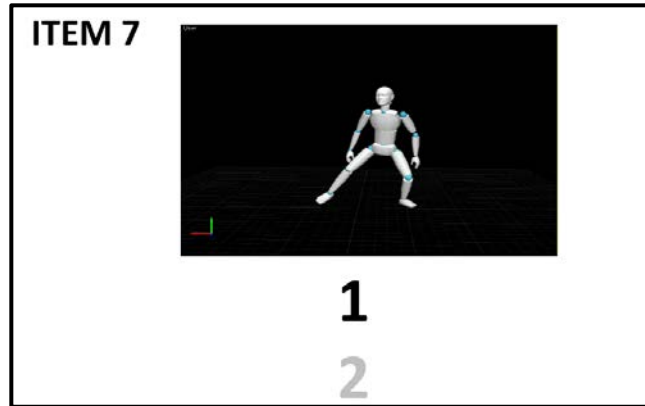
Figure 5. Screenshot of an example of test item /sol/ vs. /su1/ associated with exaggerated motion (robot crab-walking with large steps).

The associated nonce words were all different from those used in the Exp. 1. As there were 50 items with each item taking approximately 12 seconds to complete, the total time for the Exp. 2 was 13 minutes (3 minutes for the introduction and 10 minutes for the items). The sequencing of the task was shown in Table 10.

Table 10.

Sequencing of Forced-Choice Task (Exp.2).

Phases	Time
Introduction	3 mins.
PowerPoint Slide Presentation for Each Item	
Participant views video and hear Audio Clip #1.	4 seconds
Participant views same video and hear Audio Clip #2.	4 seconds
Participant verbally selects the most fitting audio clip.	4 seconds
	Total: 12 seconds (each item).
	50 items X 12 seconds = 10 mins.
	Total: 13 mins.

5.2 Results

Experiment 1 was out of 50 points, with each nonce word item being scored as "1"

if the response of the test subject was English congruent and "0" for a non-congruent

answer. Experiment 2 had an identical scoring system to Experiment 1. The measure of

internal consistency for Experiment 1 and 2 was considered acceptable with a Cronbach's

alpha of 0.723, suggesting that the two experiments measured the same underlying

construct of magnitude SS knowledge. The results of the Shapiro-Wilk test indicate the

data for Experiment 2 were normally distributed ($p > .05$). Figure 6 displays the groups'

average performance for Experiment 2.
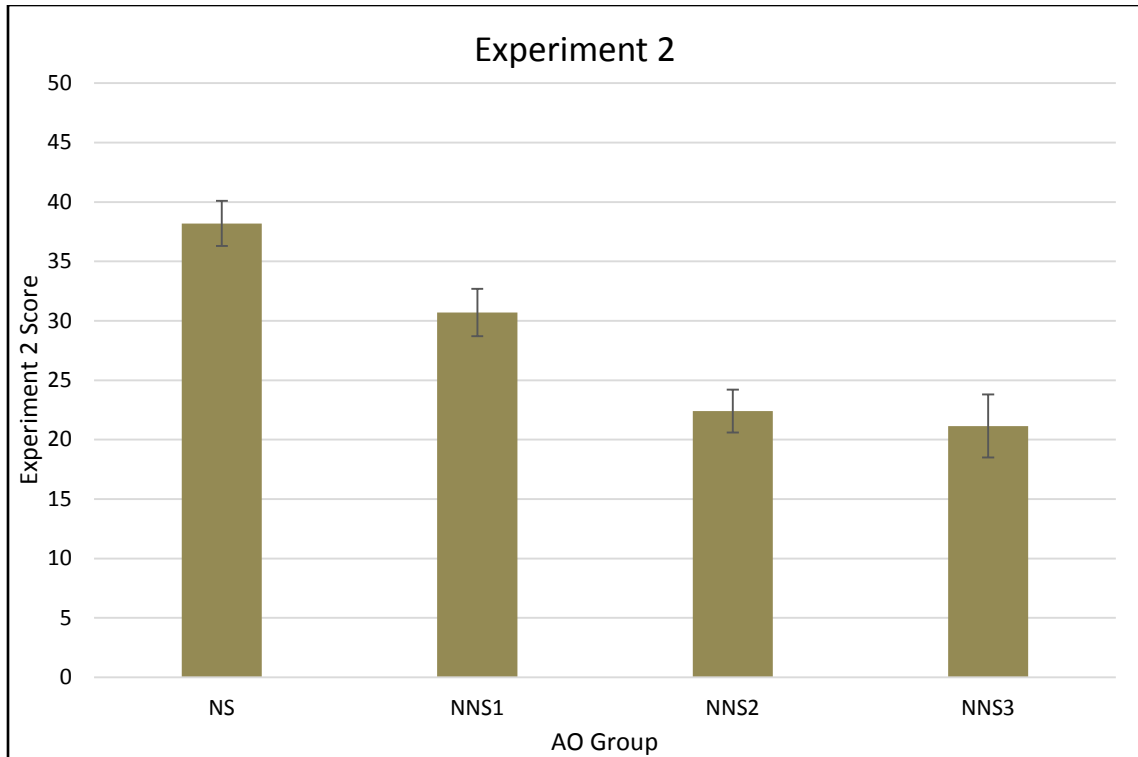
Figure 6. Group average performance for Experiment 2.

As seen in Figure 6, the control group had the highest performance on Experiment 2 at approximately 76% ($M = 38.2$), suggesting that NSs had greater levels of English-congruent magnitude SS intuitions relative to NNSs. The early NNS1 group (AO 3-9) had lower average performance compared to NSs at nearly 61% ($M = 30.7$). The two late NNS groups (AO 10-16; 17+) had notably lower demonstrations of magnitude SS knowledge ($M = 22.4$ and 21.1, respectively). The similarity in scores between the two late learner groups suggests that the language learners who have been intensively exposed to English at the ages of 10 to 25 had similar degrees of English-congruent magnitude SS intuitions.

The NS controls and the early NNS1 group (AO 3-9) had notably similar levels of variability in Experiment 2 scores ($SD = 4.11$, and 4.22, respectively). The late NNS2

group (AO 10-16) had the smallest standard deviation value ($SD = 3.76$) whereas the late

NNS3 group (AO 17+) had the highest ($SD = 5.67$) (see Table 11).

Table 11.

Group Mean and Mean Percentage Scores on Experiment 2

Group	Experiment 2			
	M	*M%*	*SD*	95% CI
Control (*n* = 20)	38.2	76	4.11	36.3-40.1
NNS1 (AO 3-9) (*n* = 20)	30.70	61	4.22	28.7-32.7
NNS2 (AO 10-16) (*n* = 20)	22.40	45	3.76	20.6-24.2
NNS3 (AO 17+) (*n* = 20)	21.15	42	5.67	18.5-23.8

Note. n = sample size, *M* = average score, *M%* = average percentage score, *SD* = standard deviation, 95% CI = 95% Confidence Interval

Overall, the NS group answered with approximately 15% more English-congruent magnitude SS responses compared to the early learners (AO 3-9). The early NNS1 group scored about 16% better than the late NNS2 group (AO 10-16), whereas the difference in average performance between the two late AO groups (AO 10-16; AO 17+) was small at approximately 3%. There were no outliers found in the data set for Experiment 2.

Levene's test was not significant ($p > .05$), so the null hypothesis of homogeneity of variances was retained for the Experiment 2 data distribution. A one-way ANOVA was conducted to compare the effect of AO on magnitude-related SS intuitions in early and late learners. There was found to be a significant effect of AO on SS knowledge at

the $p < .05$ level [$F(3, 76) = 71.29$, $p < 0.0001$] for language learners. Scheffé post hoc analyses indicated that there was an insignificant difference between the late NNS2 (AO 10-16) ($M = 22.4$, $SD = 3.76$) and the late NNS3 (AO 17+) ($M = 21.15$, $SD = 5.67$) groups ($p = .86$, 95% CI [-2.8, 5.3]), suggesting that English learners with AOs ranging from 10 to 25 years of age (i.e., early puberty to adulthood) had similar magnitude SS intuitions when forming assumptions about unknown words. However, all other group combinations were found to be significantly different from each other. The NS controls ($M = 38.2$, $SD = 4.11$) differed from the early NNS1 group (AO 3-9) ($M = 30.7$, $SD = 4.22$) with respect to levels of magnitude SS knowledge ($p = .005$). The early NNS1 group (AO 3-9) was also found to be significantly different from the two late learner groups ($p < .001$ for both group comparisons).

These results were very similar to Experiment 1, where the only group combination that did not differ from one another were the two late AO groups ($p = .73$). The average performance of the NS controls and the three AO groups, too, were remarkably similar to data found in Experiment 1. Experiment 1 and 2 were both measuring age effects in the same target feature (English magnitude-related SS patterns), with the only difference being that Experiment 1 presented an auditory input to be matched with two visual inputs and Experiment 2 presented the reverse of a visual input to be matched with two auditory inputs. As the average score and Scheffé post-hoc analyses were similar across the two experiments, this suggests that the experimental design has high reliability in terms of measuring the target construct of magnitude SS knowledge.

With respect to effect sizes between adjacent groups, the effect size was largest between the early NNS1 group (AO 3-9) and the late NNS2 group (AO 10-16), (Cohen's

$d = 2.1$). Such a large effect size signifies that the difference between the two means is larger than two standard deviations, indicating that AO has a large effect across these testing groups. The effect size between the NS controls and the early NNS1 group (AO 3-9) was relatively smaller ($d = 1.8$). As the two late groups were similar in overall Experiment 2 test performance, the effect size between the late learners (AO 10-16; AO 17+) was the smallest ($d = 0.3$). Notably, a similar pattern of effect size values was found in Experiment 1, with the largest effect size being between the early learners (AO 3-9) and the first late learner group (AO 10-16) and the smallest effect size being between the two late groups (AO 10-16; AO 17+).

5.3 Discussion

The results of Experiment 2 were similar to Experiment 1, which helps validate that the data did represent a normal case and was not changeable due to alterations in the experimental design. The purpose of Experiment 2 was to determine whether semantic associations would be more clearly recognized by participants if presented in the form of two sequential auditory inputs (i.e., one video with two target words). This contrasts with the Experiment 1 testing design, with two simultaneous visual inputs having to be matched with one auditory input (i.e., two video with one target word). Put differently, altering the testing design from two simultaneous visual inputs to two sequential auditory inputs did not change the participants' opinions about which vowel sounds matched with motions of small or large magnitude.

This similarity in results between Experiment 1 and 2 provides evidence for the existence of magnitude-related SS, corroborating similar findings in previous research in

the area of SS. For example, Thompson and Estes (2011) found that adult English speakers consistently associated names containing "large" phonemes (a, u, o, m, l, w, b, d, and g) with items of large magnitude and "small" phonemes (i, e, t, k) with smaller items. Additionally, Peña et al. (2011) found that infants acquiring their English L1 associated high vowels (/i/ or /e/) with items of small magnitude and low vowels (/a/ or /o/) with items of large magnitude.

The current results show that English NSs consistently associated the vowels /a/, /æ/, and /o/ with larger, exaggerated movements and the vowels /ə/, /u/, /e/, and /i/ with smaller, constrained movements, whereas the two late learner groups (AO 10-16; 17+) tended to have opposite intuitions about the form-meaning mappings. In other words, when compared to NSs and early learners, the late learner groups demonstrated lower sensitivities to English SS patterns when mapping unknown words to meaning. This was consistent with the Hypotheses 1a. Why would late learners of English consistently show reduced magnitude SS sensitivities across Experiments 1 and 2?

Recent research has discovered that toddlers have sensitivities to SS that is not only universal or cross-linguistically shared, but also language specific SS patterns of novel languages that deviate from the SS of the L1 (Imai & Kita, 2014; Kantartzis, 2011; Yoshida, 2012). These findings have led to the definition of the *sound symbolism bootstrapping hypothesis*, where one of the key components is the theory that young child learners possess intuitions about a wider range of SS form-meaning associations than their adult counterparts, but such sensitivities are pared down as children master the native tongue. Researchers have noted that this phenomenon is also observable in studies of universal and language-specific phonemic contrast sensitivities (Imai & Kita, 2014;

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Kantartzis, 2011). Werker, Yeung, and Yoshida (2012) speculated that infants are born with sensitivities to all phonemic contrasts, but with age, young learners prune down their sensitivities to those congruent with the native language. As infants are exposed to L1 input, the young learner quickly learns how to ignore other ambient languages and instead hone in on speech with linguistic features consistent with the main language being learn (Werker & Tees, 1984). Additionally, McDonough et al. (2003) have found that infants with either a Korean or English L1 were sensitive to the language-specific spatial relations (i.e., tight containment vs. loose support) that were not present in their L1s, whereas adult NSs of English had reduced sensitivities to the spatial relations specific to Korean that were nonexistent in their L1. Even before infants can speak, they are already capable of conceptualizing both universal and language-specific form-meaning mappings. They suggested that the tendency for preverbal infants to categorize a wider range of spatial relations allows them to build a foundation for the prospective learning of the native language, "thus giving them a starting place from which linguistic terms (whether English or Korean) can be learned in a meaningful way."

Taken together, there appear to be similarities between the loss of sensitivity to semantic concepts such as spatial relations (or phonetic categorization) and the loss of sensitivity to sound-meaning pairings (such as magnitude SS patterns) by adult learners that are not supported in their native language. Therefore, the present research will propose that a key factor behind the late learners' reduced SS pattern sensitivities in Experiment 2 compared to the NSs and early learners is that late learners may have already become insensitive to subtle linguistic features like magnitude SS that are inconsistent, or even opposite to their L1. As magnitude SS is unlikely to be taught in

classroom settings and are nonetheless challenging to acquire explicitly due to their probabilistic patterns, the late learners lack both the opportunity and the cognitive tools to develop sensitivities to the SS of the new language. This leads to an additional focus of the study that could explain late learners' reduced SS sensitivities: the diminished abilities of adult learners for implicit learning. Around early adolescence, learners are theorized to experience significant declines in the ability to implicitly extract abstract linguistic patterns (DeKeyser, 2000).

In sum, the late learners' difficulty with recognizing L2 magnitude vowel SS stems from the combination of two phenomena. First, the observation is that language learners, after preverbal infant ages, tend to unconsciously hone in on linguistic input consistent with the L1 by disregarding ambient languages. During childhood, the language learner adapts their processing of linguistic input so that the native language can be comprehended and produced in the most efficient way possible; in other words, the "refined implicit processing mechanisms…[are] 'set' for the L1 and no longer 'tuned' appropriately for the new language" (Long, 2014). The late learner groups (AO 10-16; 17+) have acquired the L2 with cognitive systems specialized solely for Korean SS form-meaning patterns, but these sophisticated L1 processing techniques ironically hinder the learners from developing sensitivities to L1-incongruent English SS patterns. Second, the late learner groups would have diminished implicit learning abilities compared to younger learners and NSs, and instead rely more on explicit problem-solving mechanisms to process the L2. As SS patterns are highly irregular in nature, the older learners would have difficulty extracting regularities from such statistical linguistic input with their reduced implicit learning capabilities (DeKeyser, 2000; Janacsek et al., 2012).

Hypothesis 1b was consistent with what was predicted: the two late learner groups demonstrated similar sensitivities on the magnitude SS task. As in Experiment 1, the group similarity will be interpreted as a discontinuity in the age-related decline in SS knowledge.

Inconsistent with Hypothesis 1c, the early learners (AO 3-9) did not demonstrate similar levels of magnitude SS intuitions as NSs when mapping unknown words to meaning. The present research originally predicted that early L2 learners would develop nativelike magnitude SS sensitivities due to their early ages of exposure to the L2, as many SPH studies involving other language areas have found early learners capable of demonstrating linguistic competence comparable to NSs (e.g., DeKeyser, 2000; Granena & Long, 2013a). However, a growing body of evidence suggests that early exposure is a *necessary* but ultimately *insufficient* condition for reaching nativelike language abilities (Abrahamsson & Hyltenstam, 2009; Hyltenstam & Abrahamsson, 2003). Granena and Long (2013a) have proposed that "eventual native-like attainment…is not guaranteed for sequential bilinguals first exposed to the L2…even when exposure continues to be plentiful, precisely because of the heavier learning task the sequential bilingual child faces, in the form of two languages instead of one." The early learners in this study were sequential bilinguals who had intensive exposure to Korean until approximately the age of 3 to 9 years, and then began to acquire English after that respective age. The early learner group (AO 3-9) is faced with having to develop two opposite form-meaning mapping solutions for the magnitude SS of their L1 and L2. Given this, a plausible explanation for the early learners' non-native-like demonstration of magnitude SS sensitivities is the cross-linguistic influence of the Korean L1 on the English L2 for the

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early learners, but this claim must be treated with caution due to the lack of previous research testing cross-linguistic interaction on magnitude SS patterns.

With respect to the choice of age groups, it is also possible that the early learner group did not include a sufficient number of participants that were first intensively exposed to English at more sensitive, early childhood ages. The average AO for the early learner group was approximately 6 years old, and the mode of the AO distribution was 5 with a range of 3 to 9 years of age. Meisel (2004) has noted that "exposure to another language during childhood, i.e. approximately between the age 5 and 10, can indeed be considered as child L2, resembling more adult L2 than bilingual L2 development." Perhaps shifting the AO range before the age of 5 would more clearly reveal which AO group possesses native-like magnitude SS sensitivities. Notably, the early learner group (AO 3-9) still performed better than the two late learner groups (AO 10-16; 17+) in terms of mapping unknown words to meaning of the magnitude SS with average performances above chance level. This was consistent with Hypothesis 1a.

CHAPTER 6: EXPERIMENT 3
Sound-Symbolic Patterns and Word Learning

Experiment 3 was designed to examine NNSs' intuitions regarding form-meaning correspondences that were assumed to exist within the English SS system. Because the targeted form-meaning patterns that are associated with the assonances (syllabic onsets) and rimes often involve consonant clusters that do not appear in Korean, the NNS participants in the experiment were likely to be minimally influenced by cross-linguistic transfer from their L1.

Notably, the lack of the phonaestheme SS structure in Korean could potentially hinder NNSs' learning of these features (Dekeyser, 2005). The current study utilizes a within-subjects design, or gives the three experiments to the same four experimental groups, which may cause the participants to be vulnerable to potential carryover effects. However, the increasing variability of the target feature in experimental design lowers the probability of these carryover effects; incorporating a third experiment that is not vulnerable to cross-linguistic interference allows more visibility to whether cross-linguistic interference is significantly affecting results.

Participants received instruction in which they learned meanings associated with nonce words. The words differed: some words had form-meaning correspondences consistent with English sound-symbolic patterns; other words had form-meaning mappings that did not correspond to these patterns.

6.1. Method

6.1.1 Materials

A PowerPoint slide show was used to present the materials on a computer screen. The slides were all timed so that the instructional time and number of presentations of each nonce word were identical. Half of the nonce words (the "SS-consistent" words) were matched with meanings that were consistent with the sound-symbolic properties of the words. The other half (the "SS-inconsistent" words) were matched with meanings that were inconsistent with the sound-symbolic properties of the words. The sound-symbolic meanings were based on those proposed in previous research (see Appendix C). The sound-symbolic patterns used in the experiment were those that have received support from linguistic analysis or empirical research. In other words, prior research will support the conclusion that the sound-meaning relationship of the target patterns is much stronger than would be expected to occur by chance.

The nonce words were formed by exploiting possible combinations of assonance and rime that do not occur in English words. For example, the nonce word *stolt* was assigned the meaning "to suddenly leap upward, reaching one's hands into the air so that the body's in a rigid line." The meaning of the coined term reflected the meaning for both the word's assonance and rime. A number of researchers have suggested that the *st-* sound in words such as *stand* is association with rigidity, strength, and linearity. Hutchins (1998), for example, claims that the sound is associated with something upright, regular, or powerful or something with a forceful linear motion. Drellishak (2007)'s quantitative research employing Latent Semantic Analysis has strongly confirmed Hutchin's analysis, finding that dictionary definitions of *st-* words, relative to words that do not begin with *st-*, are much more strongly associated with words such as *firm*, *fixed*, *upright*, *resolute*, and *obstinate* (e.g., *stab, stiff, and stubborn*). Rhodes and Lawler (1981), based on their own

analysis, have concluded, along similar lines, that the sound is associated with linearity and rigidness.

Turning to the rime, Hutchins (1998) claims that *–olt* is associated with a powerful, high-energy force in motion which is often sudden, angular, or violent. Drellishak (2007) has, to some extent, confirmed this analysis, finding that the words *electromotive*, *sudden*, *spring*, *shake*, *shock*, and *suddenly* (e.g., *volt, bolt, jolt, and revolt*) showed a distributional bias, appearing more often in definitions of words ending with *–olt*. Figure 7 shows an example of a SS-consistent item targeting the nonce word *stolt*.

stolt = to jump up so that the body's in a straight line

Example: As part of her routine, she *stolts*.

Figure 7. Example of a SS-consistent item in the word-learning experiment.

The materials also included a set of meanings that were inconsistent with the nonce words' SS. These words were designed to mark similar semantic features (e.g., degree of suddenness or rigidity); however, their meanings were inconsistent with the sound-symbolic elements (i.e., the assonance and rime) of the matched nonce word (e.g., *stolt*).

For example, the incongruent meaning paired with *stolt* referred to the act of gently stretching so that the torso was bent at a curved angle. Figure 8 shows an example of a SS-inconsistent item targeting the nonce word *stolt*. These items are provided in Appendix D.
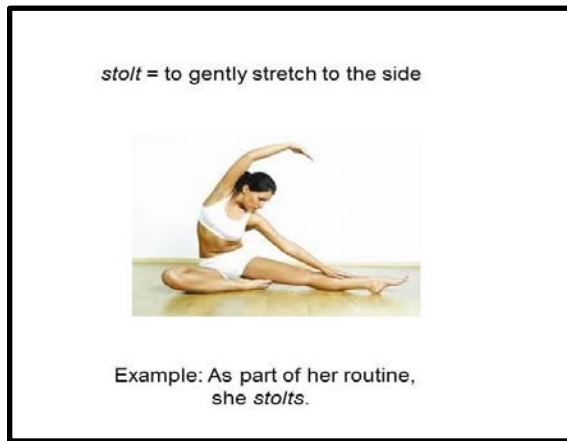
Figure 8. Example of a SS-inconsistent item in the word-learning experiment.

The materials were split into an A list and a B list. Half of the participants in each group received the A list paired with congruent meanings and the B list paired with incongruent meanings. The other half of the participants in each group received the A list paired with incongruent meanings and the B list paired with congruent meanings. This counterbalancing was done to avoid confounds resulting from some words' potentially being easier to learn due to factors unassociated with the experiment (i.e., nuisance variables). The A and B list words were presented in random order with the stipulation that any congruent word-meaning pairing can only be followed by one more congruent pairing. (The same stipulation applied to the incongruent word pairings). This pseudo-

random sequence was then, in turn, counterbalanced so that words appeared equally on the initial, middle, and final third of the materials that were given to each group. This was done to prevent performance on some words being higher due to their consistent appearance at particular points during the instruction.

6.1.2 Procedure

Participants were told that they were going to learn some newly coined English words, and that they would be tested on their knowledge of the word after hearing six words. On the instructional PowerPoint, each target word appeared with its definition (which may be congruent or incongruent, depending on the role of the item within the instructional materials given to the participant. As the word was shown, the participant heard (via an audio file embedded in the PowerPoint presentation) the pronunciation of the word. They then saw an explanation of the word's meaning as they saw a graphic associated with the meaning. All audio portions of the instructional materials were read by a NS of English. The instructional materials for one exposure to one target word lasted 15 seconds. After this time, the slide automatically advanced to the next item. In other words, participants had no control over the speed or duration of exposure to each item.

After a slide showing the meaning of the word, a slide showed an English sentence that used the word. As in Figure 7 and Figure 8, both the SS-congruent and SS-incongruent slides used the same example sentence. This was done to ensure that one group did not have an advantage due to exposure to more or less memorable example sentences.

After exposure to the PowerPoint materials targeting six words, the participants saw the original graphic with the six words that they recently learned in boxes below the graphic. They were asked to click on the word that corresponds to the graphic. If they were correct, they would hear a chime and the slide will advance. If they were wrong, they would hear a buzz. In this case, they were required to select a different answer, repeating the process until they selected the correct answer. Participants continued to study the target words presented in four blocks of six words. They were told that they would now go through the words one final time after finishing the list.

In the second exposure, the 24 words were presented in a different order. The graphics and example sentences associated with each word were also different. Moreover, the wording of the definitions was slightly changed. These modifications were done to ensure that each word was associated with its target semantics instead of being associated with arbitrary features of the materials (e.g., the size of the picture or a salient expression in the definition). The total instructional time, including introductory examples and explanations, was 43 minutes.

Following the second exposure, participants were allowed to take a break for 7 minutes. Participants were then given a test. For each test item, participants saw a graphic and heard a definition. They were then given a sentence frame. They were asked to write the word that would go into the sentence frame. The graphic, the wording of the definition, and the sentence frame were also slightly different from those used in the instructional materials. This was done to ensure that participants knew the meaning and were not able to guess the word by focusing solely on extraneous elements of the instructional materials. The sequencing of Experiment 3 task is shown in Table 12.

Table 12.

Sequencing of Word-Learning Task (Exp.3)

Phases	Minutes
Introduction	4
Learning Phase One	
● First view of slides	6 (15 seconds for each slide)
● Short quiz after six slides	8 (20 seconds for each slide)
Learning Phase Two	
● Same as above	17
Break	7
Testing Phase	
● View slides and write answers	8 (20 seconds for each slide)
	Total: 50 mins.

6.2 Results

Experiment 3 contained 24 nonce words with a maximum of 24 points. The 24

nonce words tested were composed of assonance and rime combinations with sound-

meaning correspondences involving English phonesthemic SS systems. Half a point was

given if the participant correctly supplied the lexical item's rime or assonance. If the

participant remembered both the assonance and the rime of the nonce word on the word-

learning task, a full point was given. However, the participant would get zero points on

the question if neither the assonance nor rime could be recalled correctly. The Cronbach's

alpha value for Experiment 3 was also acceptable with a value of 0.680. The alpha was

set at .05 for analyses. Table 13 shows the average raw scores for the congruent and

incongruent items on Experiment 3.

Table 13. .

Average Raw Scores for the Congruent and Incongruent Items on Experiment 3

	NS	NNS1 (AO 3-9)	NNS2 (AO 10-16)	NNS3 (AO 17+)
Congruent Score	9.33 (1.92)	8.75 (1.37)	7.45 (1.68)	6.43 (1.71)
Incongruent Score	6.40 (1.71)	6.93 (2.15)	7.90 (1.76)	7.08(1.70)

Note. Standard deviations appear between parentheses.

If the participants were not affected by the existence or nonexistence of SS in the nonce words, performance on both the 12 English congruent words and the 12 English incongruent words should be similar, with an average score of approximately zero after the covariate has been factored out. This controlled for the possibility that one group might be better at vocabulary learning than the other.

The unadjusted congruent score averages were not used to prove or disprove the hypotheses due to potential interference from individual differences in vocabulary learning ability. For example, a NNS learner that had difficulty memorizing words incorporating incongruent SS could still receive an exceptionally high score if they had above average vocabulary learning ability. The nuisance variable of vocabulary learning ability was controlled for by defining incongruent scores as a covariate in the analyses. Although Experiment 3 scores do not measure individual differences in vocabulary learning ability in the scope of the word learning task, the degree of sensitivity to phonesthemic SS patterns would theoretically bolster learners' abilities to learn unfamiliar words as English lexicon contain congruent SS patterns in the assonance and rime of verbs at a rate greater than chance (Bergen, 2004). It would be impractical to consider a high score on Experiment 3 as a measure of SS sensitivity, as the learner could

possess high aptitudes for "explicitly" remembering novel words regardless of their SS sensitivities. That is why perfect 100% scores on the task are useless to the study, as they reveal nothing about how the learner was affected by the SS in the words during learning. The learners' sensitivities to the congruence or incongruence of the words' phonesthemic form-meaning association in the local scale of the study would be a measure of their ability to utilize SS to bootstrap their learning of new words in the global scale of vocabulary learning.

After incongruent scores are factored out in the analyses, the average score would be close to zero if the English congruence or incongruence of the vocabulary word did not affect the participants' ability to memorize the lexical item. In other words, whether or not the participant scored highly or poorly on the word-learning task, the adjusted score would be low if the participant was not affected by the English phonesthemes present in the lexical items as the number of the correctly recalled congruent items would be proportionate to the incongruent items. On the other hand, the adjusted score would be at the maximum of the range distribution if the participant only scored the congruent lexical items correctly and could not learn any incongruent SS words (i.e., being highly affected by phonesthemes present in the words during word learning).

After factoring out the incongruent score, the mean performance of the NS group was highest at 9.46 (*SE* = 0.33), 95% CI [8.81, 10.11]. As the mean score was not around zero after the covariate was factored out, it can be assumed that the participants had sensitivities to the existence of sound-symbolic patterns in the nonce words when learning vocabulary. This is as expected, as English NSs would better be able to remember the definition of nonce words if the lexical items were congruent with English

SS form-meaning patterns, whereas late NNSs were hypothesized to have reduced sensitivities to the existence of these sound-symbolic assonances and rimes when using SS bootstrapping to learn the meanings of new words. The early NNS1 group (AO 3-9) had comparable performance with an adjusted mean score of 8.82 ($SE = 0.33$), 95% CI [8.18, 9.48]. The average performance of the early NNS1 group suggests that the child learners (AO 3-9) had intuitions comparable to NS controls with respect to phonesthemic SS. The late NNS2 group (AO 10-16) had a lower adjusted mean of 7.15 ($SE = 0.33$), 95% CI [6.49, 7.81], whereas the late NNS3 group (AO 17+) had the lowest performance ($M = 6.30$, $SE = 0.33$), 95% CI [5.63, 6.97]. It is important to note that the adjusted mean for test participants with an AO beyond 17 was still above zero; in other words, the scores on incongruent and congruent items was not balanced, suggesting that even late NNSs were affected by the presence of SS in the nonce words. However, these data results suggest that the latest AO group (AO 17+) was not equally affected by phonesthemic SS in the lexical items as NS controls (see Table 14). Additionally, Figure 9 displays the adjusted mean scores for all groups.

Table 14.

Group Adjusted Mean Scores and Standard Errors on Experiment 3

Group	Experiment 3		
	N	M	SE
Controls	20	9.46	0.34
NNS1(AO 3-9)	20	8.83	0.32
NNS2 (AO10-16)	20	7.15	0.33
NNS3 (AO 17+)	20	6.30	0.33

Note. N = sample size, M = adjusted average score, SE = standard error
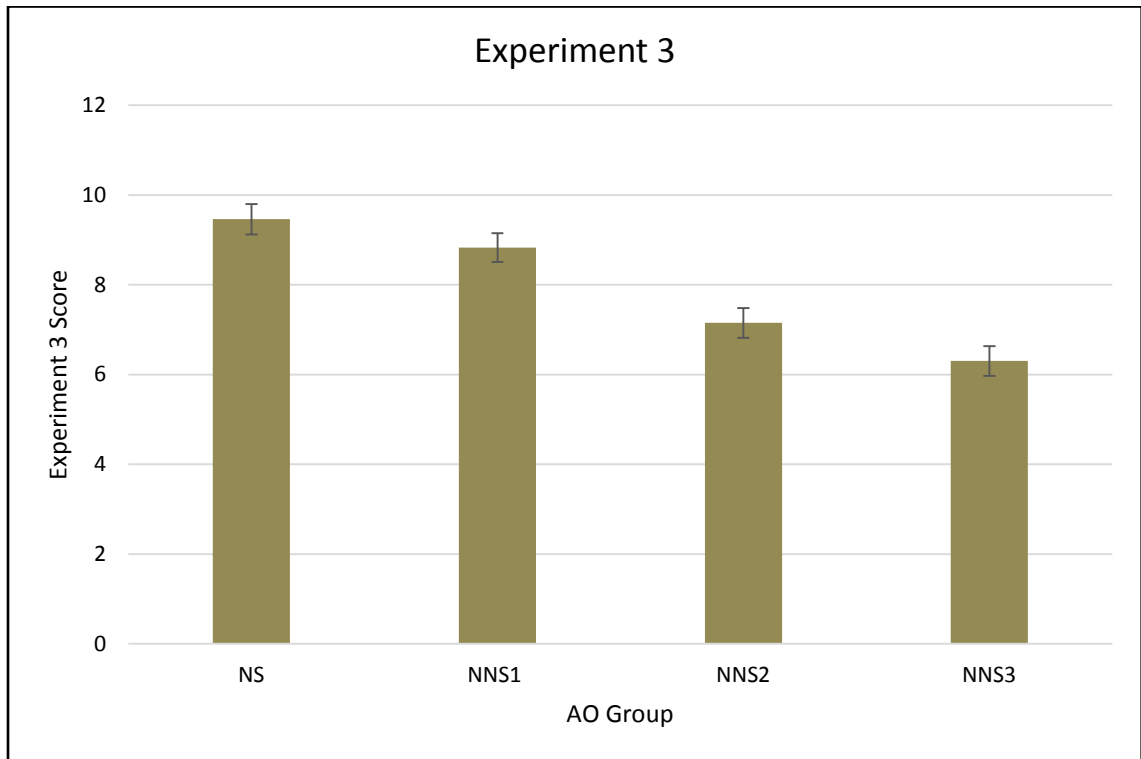
Figure 9. Group average performance for Experiment 3.

A one-way ANCOVA was conducted to examine the effect of Learner Type (i.e., NS and NNS) on English phonesthemic SS sensitivity as measured by Experiment 3 while controlling for vocabulary learning ability. Congruent scores were treated as the dependent variable and incongruent scores were treated as the covariate. Learner Type was treated as a between-subjects variable with three levels: NS, Early Learner, and Late Learner. Assessment from a scatterplot revealed that there was a linear relationship between congruent and incongruent scores for each learner group. There was homogeneity of regression slopes. The Shapiro-Wilk's test confirmed that standardized residuals for the interventions and the overall model were normally distributed ($p > .05$). There was homoscedasticity and homogeneity of variances, as assessed by scatterplot and Levene's test of homogeneity of variance ($p = .347$), respectively. There were no outliers in the data set (i.e., there was no case with a standardized residual greater than ±3 standard deviations). There was a significant effect of Learner Type on congruent item score after factoring out the covariate of incongruent item score (i.e., controlling for vocabulary learning ability), $F(3, 74) = 19.575, p < .001, \eta^2 = .442$. The partial eta squared value of .442 indicates that Learner Type accounted for approximately 44% of the variance between groups.

Post-hoc analysis was performed with a Bonferroni adjustment. The Early NNS1 group (AO 3-9) did not differ significantly from controls ($M_{diff} = 0.633$, 95% CI [-0.615, 1.880], $p = 1.000$). These results suggest that the child learners could demonstrate native-like English SS sensitivities when acquiring new vocabulary after controlling for vocabulary learning ability. However, the NS group demonstrated statistically significantly greater English phonesthemic SS sensitivities compared to both the late

NNS2 group (AO 10-16) (M_{diff} = 2.308, 95% CI [1.033, 3.583], $p < .001$) and the late

NNS3 group (AO 17+) (M_{diff} = 3.161, 95% CI [1.887, 4.424], $p < .001$). In other words,

participants with an AO beyond approximately 10 years of age did not have NS levels of

English phonesthemic SS sensitivities when learning novel words. Additionally, the early

NNS1 group (AO 3-9) was found to have higher levels of English SS intuitions as

measured by Experiment 3 when compared to the late NNS2 group (AO 10-16) (M_{diff} =

1.675, 95% CI [0.407, 2.943], $p = .004$) and the late NNS3 group (AO 17+) (M_{diff} =

2.528, 95% CI [1.265, 3.791], $p < .001$). Compared to late learners, early learners

demonstrated greater knowledge of English lexical items that are based on sound-

symbolic patterns. Lastly, the late NNS2 group (AO 10-16) was found not to differ

significantly from the Late NNS3 group (M_{diff} = 0.853, 95% CI [-0.433, 2.138], $p =$

0.458). This suggests that the two groups of late learners, or participants with an AO

between 10 to 26 years of age, demonstrated similar levels of English phonesthemic SS

sensitivities on a nonce word-learning task.

6.3 Discussion

    The acquisition of English phonesthemic SS patterns was affected by AO in the

manner predicted by the hypotheses. The early learners (AO 3-9) were found to be

similar to NSs with respect to utilizing phonesthemes to bootstrap their learning of

unknown SS words (consistent with Hypothesis 2c). In other words, the presence of

English congruent SS in the novel lexicon was found to have a facilitating effect on the

memorization of the nonce words, whereas English incongruent SS was found to have a

negative effect on the participants' recall of newly learnt vocabulary for both early

learners and NSs.

Compared to the NSs and early learners, the two groups of late learners (AO 10-16; 17+) demonstrated less utilization of phonesthemes on Experiment 3 (compatible with Hypothesis 2a). This suggests that late learners had reduced sensitivities to phonesthemes when compared to early learners and NSs. Perhaps the two late learner groups had already tuned their implicit learning strategies in ways that were more ideal for processing Korean SS patterns; more specifically, late learners could have developed sensitivities to potential SS patterns in adverbs (Korean congruent) rather than in verbs and nouns (English congruent). In the light of this, the late learner would most likely be selectively receptive to SS in the adverbs of the L2 input where English phonesthemes don't typically exist, ultimately hampering their ability to develop intuitions about the relevant English SS patterns at native-like levels. On the other hand, the fact that the early learners (AO 3-9) could demonstrate native-like levels of English SS sensitivities suggests that early learners of English developed receptiveness to SS patterns in verbs and nouns when acquiring the L2 despite the SS being nonexistent in Korean.

Lastly, the late NNS2 group (AO 10-16) performed similarly to the late NNS3 group (AO 17+) with respect to the utilization of phonesthemes to bootstrap their learning of unknown SS words (in agreement with Hypothesis 2b). These results imply a discontinuity in the AO vs. Experiment 3 score function around the AO of 10 where there exists a significant shift in the decline of the acquisition of English phonesthemes. Although the age of first significant exposure to the English L2 appeared to be a determining factor in the reduced sensitivities of late NNSs to these English SS patterns, the similarity in the two late learner groups' performance on Experiment 3 suggests that

the decline with AO was not completely linear. These results are consistent with the SPH, suggesting that the English phonesthemes as a subdomain of SS was impacted by SPE. This pattern of decline is comparable to reported SPE in other language areas: a "peak" period where NNSs perform similarly to NSs, a linear decline in proficiency as a function of increasing AO, and lastly a discontinuity, after which AO has zero or minimal impact on the NNSs' performance (Granena & Long, 2013a). Similar patterns of decline have been found in phonology, morphosyntax, and lexis and collocation (Long, 1990; Munnich & Landau, 2010; Spadaro, 2013).

It is important to note that the focus of the current study was on group difference, that is, whether early and late learners differed in sensitivities to specific SS patterns, with an additional focus on the role of aptitude; the present research did not prioritize finding a specific pattern of decline, hence the lack of post-hoc correlational analysis. However, given patterns of group difference in the AO groups, the present study can discern that the area of English SS patterns does in fact show evidence of SPE and is in line with the SPH for other linguistic areas, as AO was determined to be an influential factor affecting the NNSs' reduction of sensitivities to the English phonesthemic SS patterns and the function between AO and the susceptibility to the L2 input was non-linear. The current findings suggest a possible SP for the acquisition of English SS patterns.

To reiterate, the focus of the present study was to see whether there would be a statistically significant difference between the early and late learners, and the synthesis of the results do suggest this for the acquisition of the relevant SS patterns. Why would older learners beyond the AO of 10 demonstrate reduced performance on the Experiment

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3 task? In other words, how did the independent variable of AO impact the late learners' ability to acquire English SS patterns? English phonesthemic SS have traits that suggest the patterns would be more likely to be acquired through implicit learning mechanisms. Implicit learning is often associated with the acquisition of language input that is not easily predicted by abstract rules and that is highly irregular in nature "but it's not completely random either because the likelihood of a specific type of alternation depends on certain aspects of the word/stem" (DeKeyser, 1995).

What defines English phonesthemic words as a candidate to be learned implicitly? English phonesthemes are semantically opaque, or the form-meaning mappings are inconsistent and "fuzzy" (Fordyce, 1988), but the probability of an English SS item to have phonesthemic meaning is higher than chance levels (Monaghan, Mattock, & Walker, 2012). For example, the English phonesthemic prefix *sn-* is often related to the 'nose/mouth' (i.e., *sneer*, *snore*, *sneeze*) and *gl-* to 'light/vision' (i.e., *glare*, *gleam*, *glitter*), but this pattern is inconsistent (i.e*., snake*, *snow*, and *snare* are not related to the nose/mouth and *glitch*, *globe*, and *gloomy* are not related to 'light/vision'). DeKeyser (1995) has suggested that implicit-inductive learning would be more effective than explicit deductive learning for these fuzzy linguistic domains, such as prototypicality patterns (i.e., number, case, or gender markings that are subject to allomorphy) that are often ambiguous and complex. Similarly, Shinohara and Kawahara (2010) have speculated that these semantically opaque English phonesthemic patterns would be best acquired through implicit learning, which is "well-suited for tracking statistical biases within massive amounts of noisy input." As SPE have been attributed to the older learners' reduced capabilities to acquire language implicitly (DeKeyser, 2000),

significant age effects in the acquisition of English SS patterns could be rooted in the adults' diminished capabilities to induce inconsistent phonesthemic patterns from noisy L2 input.

In short, some aspects of L2, such as SS patterns, appear to be difficult to acquire by explicit learning abilities and by adult's attenuated implicit learning abilities. The data appear to support this explanation for SPH findings, with the late learner groups (AO 10-16, 17+) scoring significantly lower than NSs and early learners (AO 3-9) on the phonesthemic word-learning task, indicating the adult learners' difficulty to learn a linguistic area that was assumed to be ideally learnt through implicit means.

In addition to the age-related attenuation of implicit abilities in older learners, the unique characteristics of the English phonesthemes may also inhibit adults from attaining native-like intuitions of these SS patterns specifically. English SS patterns, such as phonesthemes, are focused more on the assonance of words, initial consonant clusters, and rimes that are present in verbs and nouns. Korean SS, such as mimetics, are commonly found in reduplicative adverbs with specific syntactic roles. Previous research suggests that language learners tend to implicitly customize their cognitive processing mechanisms to be selectively perceptive to linguistic patterns that resemble the L1 to render L1 production more efficient, but this aspect of L1A unfortunately hinders the learner from acquiring language areas of the L2 that do not exist or are different from the L1 (Cutler, 2001). This phenomenon can be observed when adults inappropriately apply L1 parameters to the L2. For example, L2 learners of English with Italian L1 tend to acquire proficiency with English agreement cues that are comparable to the L1, but have non-native knowledge of the unfamiliar preverbal positioning cue (Bates & MacWhinney,

1987; MacWhinney, Bates, & Kliegl, 1984).

The current results suggest that the two late learner groups (AO 10-16; 17+) demonstrated reduced intuitions about English SS patterns when using SS to bootstrap lexical learning when compared to NSs and early learners, suggesting the late NNSs had diminished intuitions with respect to form-meaning correspondences in English SS. Perhaps the late learners had tuned their implicit learning strategies in ways that were ideal for processing Korean SS patterns (i.e., unconsciously having sensitivities to potential SS patterns in adverbs instead of verbs and nouns), which prevented them from developing new sensitivities about English phonesthemes at a later age. Further research is needed to ascertain the exact nature and size of this effect. For example, one could examine the influence of AO on the UA of L2 SS patterns through an additional forced-choice task that includes novel SS items within adverbs to see whether L1 Korean participants would have higher level of L2 SS intuitions for words with cues similar to L1 categories.

Regarding early learners, on the other hand, it is predicted that they would utilize English phonesthemes to a similar degree as NSs to bootstrap their learning of unknown SS words (consistent with Hypothesis 2c). Behind the prediction lies the assumption that SS intuitions are ideally acquired through implicit learning due to the statistical nature of SS form-meaning patterns, as specific phonological features tend to be associated with certain semantic features at rates greater than what would be expected by chance. Therefore, SS acquisition would require learners' sensitivity to subtle statistical biases in the input. This, in turn, would potentially suggest that early learners would ultimately have more SS sensitivities as language learners with lower AOs tend to process linguistic

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input through implicit learning mechanisms that allow these learners to develop

sensitivities to probabilistic patterns within the input. The prediction was borne out in the

data: the early learners demonstrated a level of English SS pattern sensitivities similar to

NSs.

CHAPTER 7:
Language Aptitude and L2 Sound-Symbolic Pattern Attainment

This chapter aimed to examine the potential association of language aptitude with L2 attainment of SS. The present study hypothesized that implicit language aptitude would have a moderating effect on the ability to learn English SS patterns.

Language aptitude was measured by the LLAMA tests (Meara, 2005). It consists of the battery of four subtests measuring both implicit and explicit learning ability. The LLAMA D (sound recognition test) is considered relevant to the "implicit" components of language aptitude, while the LLAMA B (vocabulary learning test), E (sound-symbolic associations test), and F (grammatical inferencing test) are considered more related to the "explicit" components of language aptitude (Granena, 2013a). A composite score was created for LLAMA B, E, and F, and are considered a measure of the learners' language aptitudes relevant to the explicit aspects of language learning.

A Pearson's correlation was run to assess the relationship between language aptitude vs. test performance on Experiment 1 and 2 measuring magnitude-related sound symbolic sensitivities in English learners for the four testing groups (NS controls; AO 3-9; AO 10-16; AO 17+). With respect to Experiment 3, partial correlations were run to determine the relationship between an individual's Experiment 3 test performance and language aptitude whilst controlling for vocabulary learning ability (i.e., factoring out the covariate of incongruent score on Experiment 3).

7.1 Instruments and Procedure

The LLAMA Test was shown to have an acceptable level of internal consistency ($\alpha = .77$) and stability in time (Granena, 2013), and was therefore used as a measure for the participants' language aptitude levels in this study.

The LLAMA Test uses obscure languages from British Columbia and Central America (which consequently controls for L1 and L2 interference confounds). The test is computerized, composed of simple visual displays and straightforward instructions given by the test proctor. A total of roughly 25 minutes was required to complete the LLAMA.

Each test has a total of 100 points that can be earned, where a score of 0 represents a very poor score (perhaps due to guessing) and a score of 100 represents an outstanding score.

7.1.1 LLAMA B: Vocabulary Learning Test

LLAMA B is composed of a platform of 20 illustrated imaginary characters. Each character is associated with a name taken from a Central-American language. The participant learned the characters' names for a timed two minutes, and then associated a character with a displayed name during an untimed testing phase. A high number of correctly matched characters and names were identified as a high vocabulary learning aptitude.

7.1.2 LLAMA D: Sound Recognition Test

LLAMA D has no images, but just an audio recording of 10 words from a British-Columbian indigenous language. There is no pre-test study period, and the participants were immediately presented with another string of 10 words that they were required to determine as either familiar or different from what was played out before. The

participants were asked to recognize subtle auditory variations within the dialogue, variations which can represent grammatical components of the language in study.

7.1.3 LLAMA E: Sound-Symbol Association Test

LLAMA E begins with a 8 x 3 keyboard of 24 syllables displayed on the screen. When pressed, an audio recording of the syllable pronunciation is played. The participants learned this unfamiliar phonetic alphabet for a timed two minutes, and then proceeded to finish an untimed study phase where, after listening to a pair of syllables, they chose between two displayed "words." The alphabet is composed of English letters, numbers, and three types of punctuation marks.

7.1.4 LLAMA F: Grammatical Inferencing Test

LLAMA F begins with a 2 x 10 keyboard of 20 blank buttons. In a five-minute pre-test study phase, the participants clicked on each button. A sentence and an image were displayed at the press of each button. The image displayed one or more characters, in some color or shape, performing some action (i.e., lifting a rectangle, walking, and so on). The participants were required to determine which grammatical component in the sentence associates with different aspects of the image, and construct a rough feel for the grammar of this unfamiliar L2. During the testing phase, participants were given two sentences and an image that was studied previously. They were asked to determine which sentence correctly matches with the given image.

7.2 Results

With respect to Experiment 1, there was a non-significant correlation between Experiment 1 test scores measuring magnitude-related SS sensitivities and LLAMA D

scores for NSs ($r = .10$, $p = .67$). For the early NNS1 group (AO 3-9), there was also no

significant correlation between Experiment 1 scores and LLAMA D performance ($r = -$

$.15$, $p = .53$). This signifies that, for NS controls and early learners, the "implicit"

components of language aptitude do not have a statistically significant relationship with

their sensitivities to English SS when forming assumptions about unknown words.

However, for the late NNS2 group (AO 10-16) and late NNS3 group (AO 17+), there was

a statistically significant positive relationship between LLAMA D performance and

Experiment 1 scores that were coincidentally identical in value after rounding to 2

significant digits for the two late AO groups ($r = .81$, $p < .001$). With respect to the

correlation between the "explicit components" of language aptitude (a composite score of

LLAMA B, E, and F) vs. Experiment 1 score, there were no statistically significant

correlations in any of the four experimental groups. This implies that the "explicit"

aspects of language aptitude had no facilitative effect on the learners' sensitivities to

English magnitude-related SS patterns. For reference, average raw scores on the language

aptitude measures are presented below, followed by Pearson's correlations between

language aptitude and Experiment 1 score (see Table 15, and 16, respectively).

Table 15.

Average Raw Scores in Language Aptitude

	NS	NNS1 (AO 3-9)	NNS2 (AO 10-16)	NNS3 (AO 17+)
Implicit LLAMA	38.75 (9.44)	38.5 (13.68)	42.25 (13.33)	39.5 (15.47)
Explicit LLAMA	195.53 (44.87)	217.5 (55.33)	202 (41.56)	195.75 (40.98)

Note. Standard deviations appear between parentheses. Implicit LLAMA = LLAMA D score, Explicit LLAMA = LLAMA B, E, and F composite score

Table 16.

Pearson Correlations for Experiment 1 Score vs. Language Aptitude

	NS	NNS1 (AO 3-9)	NNS2 (AO 10-16)	NNS3 (AO 17+)
Implicit LLAMA	.10	-.15	.81*	.81*
Explicit LLAMA	.15	.16	.29	-.17

Note. *p* < .05, Implicit LLAMA = LLAMA D score, Explicit LLAMA = LLAMA B, E, and F composite score

For Experiment 2, there was a similar pattern of results. This is as expected, as the two experiments were measuring the same construct of English magnitude SS intuitions in NNSs. The correlations between the LLAMA D "implicit" component of language aptitude and Experiment 2 score were slightly higher than the correlations found in Experiment 1, but still non-significant for both the NS controls ($r = .20$, $p = .40$) and the early NNS1 group ($r = .22$, $p = .35$). The late NNS2 group demonstrated a moderate to high correlation ($r = .63$, $p = .002$), whereas the late NNS3 group had a strong, positive relationship between LLAMA D performance and Experiment 2 score ($r = .84$, $p < .001$) that was statistically significant. With respect to the "explicit" LLAMA composite score, there were no sizable correlations in any of the AO groups for Experiment 2. These results are shown in Table 17.

Table 17.

Pearson Correlations for Experiment 2 Score vs. Language Aptitude

	NS	NNS1 (AO 3-9)	NNS2 (AO 10-16)	NNS3 (AO 17+)
Implicit LLAMA	.20	.22	.63*	.84*
Explicit LLAMA	-.28	-.08	.07	-.27

Note. *p < .05, Implicit LLAMA = LLAMA D score, Explicit LLAMA = LLAMA B, E, and F composite score.

For Experiment 3, the results from a partial correlation controlling for vocabulary learning ability signified that there was a non-significant correlation between LLAMA D and Experiment 3 performance for NS controls ($r = .05$, $p = .85$). Notably, zero-order (Pearson's) correlations showed that there was also no statistically significant relationship for the English NSs between LLAMA D and Experiment 3 score ($r = .19$, $p = .42$), indicating that vocabulary learning ability had minimal influence in controlling for the relationship between LLAMA D "implicit" aptitude and Experiment 3 phonesthemic SS pattern sensitivities. Similar patterns were found for the early NNS1 group, where the partial correlations controlling for vocabulary learning ability ($r = -.33$, $p = .15$) were comparable to the zero-order correlations where the covariate was not controlled for ($r = -.20$, $p = .40$); both signified that there was no significant correlation between these measures at the $\alpha = .05$ level. Interestingly, the late NNS2 group had a positive, statistically significant zero-order correlation between LLAMA D score and Experiment 3 score ($r = .59$, $p = .006$) when controlling for the covariate of vocabulary learning ability. After factoring out the incongruent score, the partial correlation was not significant ($r = .36$, $p = .14$) for the late NNS2 group. The patterns in the data results for the other AO groups' correlations suggest that controlling for vocabulary learning ability

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had little effect on the relationship between LLAMA D "implicit" aptitude and

Experiment 3 performance, and therefore only the zero-order correlations will be used to

refute or support the hypotheses. The late NNS3 group also had a positive, statistically

significant zero-order correlation ($r = .63$, $p = .003$). The partial correlation was also

positive and statistically significant ($r = .59$, $p = .008$) (see Table 18).

Table 18.

Pearson Correlations for Experiment 3 Score vs. Language Aptitude

	NS	NNS1 (AO 3-9)	NNS2 (AO 10-16)	NNS3 (AO 17+)
Implicit LLAMA	.19 (.05)	-.33 (-.20)	.59* (.36)	.63* (.59*)
Explicit LLAMA	.06 (.16)	.03 (.15)	.07 (.27)	-.20 (-.09)

Note. *$p < .05$, partial correlation values are in parentheses and zero-order (Pearson) correlations are to the left of parentheses. Implicit LLAMA = LLAMA D score, Explicit LLAMA = LLAMA B, E, and F composite score.

With respect to the "explicit" LLAMA score composed of LLAMA B, E, and F,

there was no significant correlation in any of the experiments for any of the AO groups or

NS controls. The results overall imply that the "explicit" components of language

aptitude had little to no effect on learners' sensitivities to magnitude and English

phonesthemic SS patterns, even after controlling for vocabulary learning ability in

Experiment 3.

7.3 Discussion

As SS patterns are presumed to be ideally learnt through sensitivities to statistical

biases in language input, implicit aptitude as measured by LLAMA D was hypothesized

to have a positive relationship between levels of SS sensitivities in late learners in the current study, but not for early learners. The data results confirmed the hypotheses: implicit language aptitude moderated late L2 learners' (AO 10-16; 17+) attainment of magnitude SS and English phonesthemic SS, but not for the early learners (AO 3-6). These results suggest that there is a significant positive relationship between implicit learning abilities and performance on tasks requiring automatic use of L2 knowledge for older learners. Furthermore, explicit aptitudes as measured by LLAMA B, E, and F were hypothesized to have no relationship with levels of SS sensitivities for both early and late learners. Table 19 summarizes the findings of the relationships between language aptitude and test scores.

Table 19.

Summary of the Findings about the Correlation between Language Aptitude and Test Scores

	Magnitude SS				English Phonesthemes			
	NS	Early NNS1	Late NNS2	Late NNS3	NS	Early NNS1	Late NNS2	Late NNS3
Implicit Aptitude	Low	Low	High	High	Low	Low	High	High
Explicit Aptitude	Low	Low	Low	Low	Low	Low	Low	Low

As Experiment 1 and 2 (testing magnitude SS sensitivities) demonstrated identical consistencies with the hypothesis, the two experiments will therefore be discussed in tandem. Hypothesis 3a predicted that the two late learner groups' English magnitude-

related SS intuitions would show a positive correlation with the "implicit" components of aptitude (i.e., the LLAMA D test) compared to NS and early learners, who would not show a sizable correlation on these measures. The data does demonstrate consistency with these hypotheses. This implies that, for participants with an AO greater than roughly 10 years of age, the greater the "implicit" language aptitude of the learner, the greater the sensitivity to English-congruent SS intuitions when forming assumptions about new words. On the other hand, for participants with an AO less than roughly 10 years of age and NSs of English, "implicit" aptitudes had no predictive effect on Experiment 1and 2 test performance.

To the best of my knowledge, no studies have been performed measuring aptitude effects on acquisition of sound symbolic intuitions across age groups, but a small number of studies have investigated the relationship between LLAMA D and test performance of linguistic areas that are more associated with implicit learning. For example, a study by (Granena & Long, 2013a) has found significant positive associations between lexis and collocations task performance and LLAMA D scores ($r = .46$, $p = 0.58$) for the late starters with AOs between 16 and 29 years of age. Similarly, Forsberg Lundell and Sandgren (2013) have also found a relationship between LLAMA D scores and collocations ($r = .58$, $p < .05$) with highly advanced L2 learners with an average AoA of 20 years, but not with grammaticality judgment, implying that high abilities in the implicit learning capacity as measured by LLAMA D are more important for the acquisition of language areas ideally acquired through sensitivities to probabilistic input.

The patterns in these results, in conjunction with the current research, suggest that the "implicit" components of language aptitude have a facilitative effect on the

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acquisition of linguistic areas that are presumed to be acquired implicitly for older learners. This suggests that the ability to learn language through the implicit extraction of abstract patterns may not completely deteriorate with age (Doughty, 2003; Long, 2014; N. Williams, 2009). Nonetheless, implicit learning abilities will be significantly reduced in adults, which explains the significant gap between the UA of child versus adult learners.

On the other hand, neither implicit nor explicit aptitude had a facilitative effect on early learners. More specifically, there was no correlation between language aptitude and levels of magnitude SS pattern sensitivity for the early learner AO group (AO 3-9) (consistent with Hypothesis 3b). It is well known that younger learners tend to mostly rely on implicit learning mechanisms when acquiring language. With respect to sound symbolism, infants and children are theorized to be biologically equipped with the ability to detect regularities in complex language input, therefore allowing them to perceive SS form-meaning correspondences (Imai & Kita, 2014). Previous research has posited that language aptitude would not have an effect on children's acquisition of the L2 because they are developmentally primed to learn language implicitly (DeKeyser, 2000; Montrul, 2009). Admittedly, this does not imply that all children homogeneously attain native-like acquisition of every L2 linguistic area.

Even in the present study, the early learners demonstrated nonnative intuitions about magnitude-vowel SS patterns. Why did language aptitude not explain the difference in scores amongst the early NNSs in Experiment 1 and 2? If the early AO group was capable of scoring native-like on the English phonestheme experiment, but not on the magnitude-vowel SS experiments, then one possibility is that the linguistic qualities in the tested SS patterns could cause inter-individual variability amongst the

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early learners. As English magnitude SS is the opposite of the Korean form-meaning correspondences, this could have caused other variables to come into play, such as the extent of L1 sound symbolic input before AO or how much the L1 was used while the L2 was being acquired. Although children are naturally adept at acquiring language implicitly, the child bilingual may have difficulty acquiring cross-linguistically contrasting patterns, and this could cause other confounding variables to easily affect the learners on an individual level. In sum, other factors other than language aptitude might have been responsible for the variability in the early AO group's test scores.

Language aptitude has been theorized to have no predictive power for early learners (DeKeyser, 2000; Harley & Hart, 1997). Studies have found that early L2 learners in an immersion setting have been found to reach native-like or native levels of language acquisition with little individual variation in UA outcomes (DeKeyser, 2000) Due to early learners' lack of variability in L2 proficiency compared to late learners in these studies, the impact of potential explanatory variables like language aptitude were difficult to discern (Granena, 2014; Granena & Long, 2013a). Again, few studies have examined the effect of implicit aptitude on the acquisition of probabilistic language areas across age groups. Granena & Long (2013a) has found that early learners (AO 3-6; 7-15) were unaffected by language aptitude for the acquisition of lexis and collocation, a language area that has been considered a good candidate for implicit learning (Granena & Long, 2013a). The present research, in conjunction with comparable studies (Forsberg Lundell & Sandgren, 2013; Granena & Long, 2013a), suggests that implicit learning capacities may help older learners acquire language patterns that require sensitivities to statistical biases in large amounts of language input, but not for early learners. It should

be noted that the current study and the referenced studies all involved adult learners who were natural acquirers immersed in the target language environment. This may have provided the older learners with the opportunity for extensive L2 input that is considered a prerequisite for implicit learning.

The current results are also comparable to research by DeKeyser (2000), who has found that cognitive aptitudes play a role in mitigating SPE in language acquisition; there was a strong and positive association between language attainment of grammaticality judgement and explicit aptitudes (verbal analytic ability) in adult learners. The results of the present study would suggest that implicit aptitudes, too, can be a factor allowing older learners to attain sensitivities to certain probabilistic and irregular language features. The discussion does not wish to interpret the current results as opposition to the claim of DeKeyser (2000) that older learners are largely limited to explicit learning due to the loss of the implicit ability. The present study *does* clearly show that older learners demonstrate strong age effects in such statistical language areas, suggesting that adults have attenuated implicit learning abilities consistent with the SPH. However, the fact that SPE were significant in magnitude SS acquisition, a language area not readily amenable to explicit instruction, in conjunction with the tendency for high implicit aptitudes to associate with higher performance within adult testing groups, helps verify that reduced implicit abilities associated with age may play an important role for the general inability of adults to display nativelike intuitions with respect to SS patterns, language areas with comparably statistical and irregular natures.

It should be also noted that Experiment 1 and 2 in the current research measures participants' knowledge of English magnitude SS intuitions containing cross-

linguistically different vowel contrasts in terms of sound-meaning mappings. For example, /a/ is often associated with motions of large magnitude in English, which contrasts with the small magnitude motion association of the /a/ vowel in Korean. What inspired these learners with high implicit aptitude to choose English-congruent intuitions for some of the vowel contrasts and not others is unclear, as there does not appear to be a consistent pattern in which of the five vowel contrasts were correctly or incorrectly applied to the English-congruent items. Even so, the late learners with high implicit aptitudes tended to score at above chance level, suggesting their association with respect to applying magnitude associations to these vowel sounds are closer to the English SS intuitions, whereas the other older learners with lower implicit aptitude scores often performed significantly below chance level on Experiment 1 and 2, suggesting distinctly L1-congruent SS sensitivities.

The result of this study is worth comparing to the recent research by Onnis and Thiessen (2013). Comparable to the current research, L2-English of adult L1-Korean speakers tended to have L1 congruent statistical learning biases with respect to dominant word order patterns (SOV) despite extensive exposure to English, implying that prior language experience shapes future linguistic sensitivities. However, NNSs tended to demonstrate more English congruent word order manipulations (SVO) on the sentence-processing tasks when they also demonstrated less L1 bias on artificial grammar, suggesting "individual differences in statistical learning might predict aptitude for acquiring an L2." The present study also supports the idea that the variation in scores amongst older learners may arise from differential levels of implicit language aptitudes, which may help NNS have fewer L1 biases on statistical learning tasks such as sequential

conditional information in Onnis and Thiessen (2013) and SS patterns in the present research.

Another conclusion that can be drawn from the current results is that explicit aptitudes had no effect on performance in language domains with inconsistent form-meaning mappings. LLAMA B, E, and F all had positive, but non-significant correlations with Experiment 1 & 2 scores (consistent with Hypotheses 7). Again, Granena and Long (2013a) and Forsberg Lundell and Sandgren (2013) found that the correlations between LLAMA B, E, and F (associated with explicit language learning abilities) and lexis and collocation were notably lower than those found between task performance and LLAMA D scores. Comparable to the present study, Forsberg Lundell and Sandgren (2013) also found low, non-significant correlations between the other LLAMA subtests (LLAMA B, E, and F) and collocation performance in adult learners.

With respect to Experiment 3, LLAMA D had a facilitative effect on the acquisition of SS patterns in older learners compared to younger learners ($r = .56$, $p < .05$). These results are consistent with Hypothesis 3a), predicting that the "implicit" component of the LLAMA tests (LLAMA D) would have a facilitative effect on the acquisition of English phonesthemes. Early learners, on the other hand, demonstrated nativelike English phonestheme sensitivities regardless of implicit language aptitude abilities (in agreement with Hypothesis 3b). Again, these results are comparable to former studies by Granena (2012), Granena and Long (2013a), and Forsberg Lundell and Sandgren (2013), who have found that high LLAMA D scores had strong, positive associations with sensitivities to linguistic features known to be acquired through implicit learning (i.e., lexis and collocations, and agreement violations).

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Hypotheses 3a and 3b, which predicted that the NNSs' sensitivities to phonesthemes would have low correlations with the "explicit" components of the LLAMA language aptitude tests were confirmed. LLAMA B, E and F score had low correlations with performance of English phonesthemic word-learning task. The data results imply that explicit language aptitudes have little to no impact on the acquisition of SS sensitivities to English SS patterns.

In sum, the present study was designed to test whether L2 learners are better able to extract the subtle SS patterns in the L2 if they possess high levels of sensitivities to statistical biases in noisy and extensive linguistic input. The results support this prediction, with late L2 learners with higher than normal aptitudes associated with subconscious pattern abstraction being better capable of acquiring sensitivities to English magnitude and phonesthemic SS patterns compared to their counterparts of similar AOs. This study provides supporting evidence that, like agreement violations or collocations, SS sensitivities are related to learners' implicit language aptitudes as measured by LLAMA D for adult learners specifically (Forsberg Lundell & Sandgren, 2013; Granena, 2012). Furthermore, metalinguistic knowledge (as measured by the composite LLAMA B, E, and F score) had minimal effect on the ability of L2 learners to inductively acquire linguistic patterns through massive amounts of input. These results provide support for the theory that aptitude plays a facilitative role in ultimate L2 attainment, but also emphasizes that there are variables to take into consideration: (a) the specific language aptitude construct (i.e., vocabulary learning, sound recognition, sound symbol correspondence, or grammatical inferencing), (b) the language area investigated, and (c) the L2 learners' age of first significant L2 exposure.

Another critical finding is that, whereas abnormally high explicit language aptitude has been found to correlate with near-native performance in certain language areas (Abrahamsson & Hyltenstam, 2008; DeKeyser, 2000), this phenomenon does not appear to exist between LLAMA D test performances and SS sensitivities for any AO group in this study. In other words, none of the older learners performed like NSs on the SS tasks, even if they possessed high implicit aptitudes. However, although adults do appear to have significant SPE in SS language areas, these results suggest that the older learners with extensive L2 exposure can exercise their implicit aptitudes to develop a limited ability of SS form-meaning associations and are not entirely deaf to probabilistic regularities in L2 input. All NNS had at least 10 years of extensive linguistic exposure through immersion in an English-speaking environment, and perhaps through their reduced, but still existent, implicit language-learning aptitudes, the NNSs could have unconsciously adopted a modest degree of English-congruent SS knowledge.

CHAPTER 8: GENERAL DISCUSSION AND CONCLUSION

8.1 General Discussion

The present study was conducted to compare the effects of AO on the acquisition of L2 magnitude SS and English phonesthemic SS in adults with an L1 of Korean and an L2 of English. Specifically, the impact of AOs of 3 to 9, 10 to 16, and over 17 on test scores were measured with a range of AOs from 3 to 25 ($M = 12.8$, $SD = 6.22$). Each individual group, including the English NS control group, had a sample size of 20 participants ($N = 80$). The average AO for the early NNS1 group (AO 3-9) was 5.7 ($SD = 1.49$), 13.05 ($SD = 2.06$) for the late NNS2 group (AO 10-17), and 20.1 ($SD = 2.47$) for the late NNS3 group (AO 17+).

In Experiment 1 and 2, the AO groups were found to have similar patterns of group difference and comparable average scores, as the two experiments were measuring the same construct of English magnitude-vowel SS intuition. The early NNS1 group was found to have reduced and nonnative SS intuitions, but still had a higher success rate in selecting English congruent SS form-meaning pairings than the other NNS groups. The biggest performance gap in terms of average performance and magnitude of effect size was found between the early NNS1 group and the first late NNS2 group. For Experiment 3, the early NNS1 group had comparable English phonesthemic intuitions compared to the NS after controlling for vocabulary learning ability. However, other patterns in group performance were comparable to Experiments 1 and 2. The early NNS1 group was significantly different than the late learner groups, with a greater ability to utilize phonesthemes to bootstrap their learning of new lexical items. In all experiments for both

magnitude SS and English phonesthemic SS, the two late learner groups, late NNS2 and late NNS3, were found to have similar levels of SS sensitivities. These results suggest a discontinuity in the AO-proficiency function, or a plateau after a period of steady decline, at the AOs before the late NNS2 age range (approximately 9 to 10 years of age) for the acquisition of English magnitude-vowel SS and phonesthemes. Table 20 shows the summary of the findings of the current study.

TABLE 20.

Comparison of Group Performance in the Three Experiments

	Groups in Comparison			
	Early NNS1 vs. NS	Late NNSs vs. NS	Early NNS1 vs. Late NNSs	Late NNS2 vs. Late NNS3
Exp. 1	< ✗	< ✓	> ✓	~ ✓
Exp. 2	< ✗	< ✓	> ✓	~ ✓
Exp. 3	~ ✓	< ✓	> ✓	~ ✓

Note. "~" signifies similar, "<" and ">" means significantly different with greater or lower average performance. A check mark (✓) indicates prediction was supported, and a x mark(✗) indicates refuted.

In addition, the relationship between implicit language aptitudes (LLAMA D performance) and explicit language aptitudes (LLAMA B, E, and F composite score) vs. experiment performance in the NNS groups and NS controls were examined. Interestingly, there were no differences found between magnitude-vowel SS and English phonestheme experiments for the language aptitude analyses. All subcomponents of the LLAMA language aptitude test had little to no correlation with SS knowledge for NS controls and for the early NNS1 group, implying that individual differences in language

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aptitude capabilities did not predict the learners' strength of English magnitude SS and phonesthemic intuitions. However, implicit aptitude did demonstrate a significantly positive relationship with Experiment 1, 2, and 3 performances for learners with an AO beyond age 10. This tendency suggests that late learners can apply their implicit language-learning aptitudes to acquire English SS sensitivities more successfully than their peers with lower implicit language aptitudes. The composite LLAMA B, E, and F score measuring explicit language aptitude did not have a statistically significant correlation with experiment performance for the development of magnitude SS and English phonesthemes.

As both Experiment 1 and 2 were measuring the target feature of magnitude SS, there were notable similarities in results between the two experiments. Experiment 1 and 2 had minor differences in testing design (simultaneous visual stimuli vs. sequential auditory stimuli) that did not have any observable effect in the data; group difference results and averages scores across AO groups were remarkably similar across the two experiments.

Findings aside, it is important to note the potential limitations of the study design. First, the NNSs' sensitivities to SS was measured via a forced-choice task and a word-learning task, which may elicit the application of explicit knowledge from the participants. Also, for the forced-choice task paradigm in the magnitude SS task, a participant could have arbitrarily selected a certain vowel sound for a visual stimulus due to a lack of conviction about the form-meaning association. This is particularly true for NNSs with substantial linguistic input in both the L1 and L2, where there is potential for extensive magnitude SS exposure in both languages. It is possible that they would have

endorsed a certain magnitude-vowel pairing (i.e., the Korean congruent choice of associating the vowel /a/ for a motion of small magnitude) throughout the task due to the desire to be consistent with what was chosen previously despite preferring another form-meaning mapping (i.e., the English-congruent choice of associating the vowel /a/ for a motion of large magnitude) on later questions. In future studies, utilizing a more sensitive implicit measure would control for this potential confounding variable.

Second, because the three experiments were applied in the same, sequential order for all the participants, the arrangement of the experiments could possibly affect test performance. A suggestion for future studies would be to order the experiments in all possible permutations so that this possible extraneous variable could be controlled for.

Despite these potential design limitations, I believe they do not detract from the two critical findings in the magnitude SS experiments: (1) there were significant group differences between the early and late AO groups, suggesting age effects in the domain of magnitude SS, and (2) that NSs tended to choose English-congruent responses while late learners consistently scored below chance levels, suggesting Korean-congruent preferences amongst post-adolescent language learners. The second finding provides evidence for the reality of magnitude SS in Korean and English, particularly since results were consistent across the two experiments, implying some conviction amongst the NS controls and NNS with respect to their magnitude-vowel associations (whether they were English-congruent or not) across the two tasks.

The results from Experiment 3 showed that the learning of different linguistic areas (magnitude SS vs. phonesthemes) within a single language domain (English SS patterns) could be affected by maturation in distinct ways. It is important to note that

early learners' sensitivity to magnitude SS and English phonesthemes were differentially affected by AO; the early learners (AO 3-9) displayed native-like intuitions about English phonesthemes in Experiment 3, but were found to be dissimilar from the NS control group when tested on magnitude SS sensitivities in Experiment 1 and 2. In the early learner group, 35% of the participants scored within the native range for Experiment 1 magnitude SS sensitivities. This proportion was slightly higher for Experiment 2, at 40%. In the first two experiments, nearly all of these high-achieving participants were between the AOs of 3 to 5, except for one learner with an AO of 10 who tended 149 to have high scores across the battery of tests. For Experiment 3, 70% of the participants scored within native norms on phonesthemic SS intuitions. There was a wider range of AOs among the early learners who were within the native range for Experiment 3, as the two groups were found not to be significantly different.

Both magnitude-related SS and English phonesthemic SS were hypothesized to have identical patterns of group difference, as both linguistic domains are known to be highly probabilistic in nature.

What could these differential results across experiments for group difference suggest for SPE? The answer is likely to lie, at least in part, in the fact that categorizing SS as statistical or having inconsistent form-meaning mappings does not imply that all features within the SS domain will be affected in an identical manner by maturation. Although magnitude SS and English phonesthemes belong to the same domain of SS and are both categorized as being statistical in nature, the two SS subdomains have distinct features that set them apart. As an example, the magnitude SS form-meaning pairings in the vowel sounds for the Korean L1 are the reverse of the English L2 (Kwon, 2015;

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Martin, 1962), whereas English phonesthemes have no comparable feature in Korean. Additionally, English phonesthemes are mostly found in verbs and nouns, whereas Korean SS is commonly found in adverbs. These unique characteristics within the SS subdomains give rise to several potential confounding variables, such as the cross-linguistic differences in the position of linguistic cues or the general deviation of L1 form-meaning patterns from L2 semantic associations. This may have caused differential demonstrations of SS sensitivities for the early learners in Experiments 1 and 2 vs. Experiment 3.

The study's findings with respect to language aptitude also give more evidence for the plausibility of age-related declines in implicit learning abilities being a key factor for SPE in adult learners. As implicit language aptitude had a strong, positive relationship with experiment test performance for late learners, it appears that above average sensitivities to statistical biases in language input (more specifically, high LLAMA D performance) is associated with a higher tendency to utilize SS to make assumptions about unknown lexical items or to bootstrap the learning of new words. Although adolescent and adult learners of English consistently performed poorly across all three experiments, high implicit aptitudes appear to lessen SPE in these older learners.

These results support the definition of a SPH proposed by DeKeyser and Larson-Hall (2005), stating that adults have greatly reduced abilities in implicit learning, whereas children, for the most part, acquire language by extracting probabilistic regularities from the input that enable effortless learning of formal generalizations. If older learners mostly rely on problem- solving mechanisms to learn language, and if even exceptional learners with high implicit learning aptitudes cannot gain nativelike proficiency with probabilistic

linguistic patterns, then these learners will be unreceptive to the wealth of linguistic subtleties that children effortlessly acquire. However, the adolescent and adult learners of English were not entirely incapable of acquiring language through implicit learning mechanisms, as shown by individual variation in implicit aptitude relating strongly to the ability of high implicit aptitude learners to provide English-congruent responses on more questions than their low implicit aptitude learner counterparts. This result does not go against the SPH, as the test performance of the older groups deviated greatly from the NSs, but clearly adults have some access, albeit limited, to the implicit learning mechanisms that they so freely took advantage of during childhood. The present study contributes to a growing body of research suggesting that implicit aptitudes may not have been as inconsequential as previously assumed to the acquisition of fuzzy language patterns not readily amenable to explicit instruction.

8.2. Conclusion

The aim of the current study was to test whether adult learners and child learners differ in their ultimate development of sensitivities to SS patterns. Particular attention was given to the relationship between NNSs' proportion of L2-congruent responses and their language aptitudes. Although extensive research has been performed on maturational declines in SLA, the majority of studies have concentrated on SPE in language domains such as morphosyntax and pronunciation. This has resulted in the widespread consensus that AO is a robust predictor of second language learning success, but the explanation for this relationship is not yet clear.

Recent research has proposed that the age-related attenuation of implicit learning abilities may be an explanatory factor for maturational declines in L2 attainment (DeKeyser, 2000), and this has inspired the present study to investigate age effects in language areas known to be highly probabilistic in nature: magnitude-vowel SS and English phonesthemes. Many areas of language contain inconsistent form-meaning mappings that can be frustrating for older learners who predominantly rely on explicit language-learning mechanisms. From these considerations, the SS subdomains serve as a litmus test for the difficulty older learners have in perceiving L2 patterns not readily amenable to conscious learning processes and explicit instruction. The significant group differences between early and older learners' SS sensitivity levels are interpreted as supporting evidence that maturational declines in the ability to learn implicitly could underlie general age effects in language learning.

High language aptitude has been considered an innate, inherited talent that associated with above average L2 proficiency in older learners. Mounting evidence suggests that language aptitude is a reliable predictor for ultimate language attainment, but the breaking down of language aptitude into "explicit" and "implicit" subcomponents reveals that the aptitude-UA relationship may be more complex than previously believed. Some researchers have found evidence that language aptitude has negligible benefits for early learners, as children are in a developmental stage where language is predominantly acquired through implicit cognitive mechanisms (DeKeyser, 2000; Montrul, 2009). For older learners, on the other hand, language aptitudes, such as analytic ability, have been found to mitigate the effects of developmental declines in the ability to learn language. For the present study, younger learners' variability in SS sensitivities was not explained

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by their language aptitudes, whereas late learners' demonstrations of L2 sound symbolic knowledge was heavily reliant on the individual's implicit language- learning abilities. Although the late learners demonstrated reduced SS patterns, the strong relationship between performance and implicit aptitude implies that adults may still have access to implicit learning abilities that allow them to develop some sensitivities to language patterns in a manner similar to children. Nevertheless, younger learners were clearly at an advantage across all tasks. This result, coupled with the early AO groups' lack of relationship with any language aptitude, suggests that children's natural capacity for implicit learning could be responsible for their comparative advantage in L2A. From the other side of the SP divide, the adult's inevitable attenuation in implicit learning could be behind their difficulty in acquiring language.

The current study concludes with some pedagogical implications. Researchers (e.g., Hamano, 1998) have noted that adult L2 learners often experience difficulty in acquiring sound-symbolic patterns. This can be particularly problematic for students acquiring languages such as Japanese or Korean, since the sound-symbolic system in these languages must be understood to attain high levels of expressive ability[36] and to fully appreciate important subtleties within discourse. Future studies should continue to find corroborative evidence that older learners have difficulty learning language patterns requiring implicit knowledge due to reduced implicit abilities, interventions that highlight these patterns and make them more salient may be required.

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[36] As verb-framed languages (for a discussion of verb-framed languages, see Slobin, 2004), both Korean and Japanese will often compensate for the relative lack of manner information in verbs through the use of mimetic adverbs (for a discussion of this function of Japanese mimetics, see, Sugiyama, 2005).

Appendix A

Target Items Used in the Exp.1

Contrast	Large Magnitude (Eng. SS) Nonce Word in IPA	Small Magnitude (Eng. SS) Nonce Word in IPA	English Association	Korean Association
1	bav	bəv	>	<
1	maz	məz	>	<
1	paθ	pəθ	>	<
1	faʃ	fəʃ	>	<
1	vaʒ	vəʒ	>	<
1	θadʒ	θədʒ	>	<
1	nap	nəp	>	<
1	taz	təz	>	<
1	daʒ	dəʒ	>	<
1	sal	səl	>	<
2	zap	zup	>	<
2	latʃ	lutʃ	>	<
2	tʃag	tʃug	>	<
2	dʒav	dʒuv	>	<
2	ʃaθ	ʃuθ	>	<
2	kaθ	kuθ	>	<
2	gag	gug	>	<
2	ban	bun	>	<
2	madʒ	mudʒ	>	<
2	paʒ	puʒ	>	<
3	fav	fev	>	<
3	vap	vep	>	<
3	θak	θek	>	<
3	nas	nes	>	<
3	tadʒ	tedʒ	>	<
3	dav	dev	>	<
3	san	sen	>	<
3	zaf	zef	>	<
3	lað	leð	>	<
3	tʃaʒ	tʃeʒ	>	<
4	bæz	biz	>	<
4	mæv	miv	>	<
4	pæb	pib	>	<
4	fæθ	fiθ	>	<
4	væm	vim	>	<
4	θæs	θis	>	<
4	næʒ	niʒ	>	<
4	tæf	tif	>	<

4	dæs	dis	>	<
4	sæʒ	siʒ	>	<
5	botʃ	butʃ	>	<
5	moð	muð	>	<
5	pog	pug	>	<
5	foʃ	fuʃ	>	<
5	vop	vup	>	<
5	θog	θug	>	<
5	nos	nus	>	<
5	tof	tuf	>	<
5	doθ	duθ	>	<
5	soʃ	suʃ	>	<

Appendix B
Target Items Used in the Exp.2

Contrast	Large Magnitude (Eng. SS) Nonce Word in IPA	Small Magnitude (Eng. SS) Nonce Word in IPA	English Association	Korean Association
1	baθ	bəθ	>	<
1	mav	məv	>	<
1	patʃ	pətʃ	>	<
1	fap	fəp	>	<
1	van	vən	>	<
1	θam	θəm	>	<
1	naʒ	nəʒ	>	<
1	tað	təð	>	<
1	dap	dəp	>	<
1	saz	səz	>	<
2	zak	zuk	>	<
2	laʃ	luʃ	>	<
2	tʃav	tʃuv	>	<
2	dʒap	dʒup	>	<
2	ʃal	ʃul	>	<
2	kas	kus	>	<
2	gap	gup	>	<
2	baʒ	buʒ	>	<
2	mag	mug	>	<
2	paθ	puθ	>	<
3	faf	fef	>	<
3	vas	ves	>	<
3	θag	θeg	>	<
3	naf	nef	>	<
3	tad	ted	>	<
3	datʃ	detʃ	>	<
3	saθ	seθ	>	<
3	zan	zen	>	<
3	laθ	leθ	>	<
3	tʃad	tʃed	>	<
4	bæv	biv	>	<
4	mæz	miz	>	<
4	pæm	pim	>	<
4	fæm	fim	>	<
4	væv	viv	>	<
4	θæð	θið	>	<
4	næθ	niθ	>	<
4	tædʒ	tidʒ	>	<
4	dæz	diz	>	<
4	sæf	sif	>	<

5	boʃ	buʃ	>	<
5	mof	muf	>	<
5	pon	pun	>	<
5	fov	fuv	>	<
5	von	vun	>	<
5	θok	θuk	>	<
5	nom	num	>	<
5	tog	tug	>	<
5	don	dun	>	<
5	sol	sul	>	<

Appendix C
English Sound-Symbolic Patterns Posited in Previous Research

 i. Phonesthemes: Assonance
   1. B-
     a. (Rhodes & Lawler, 1981): Rebounding
   2. BL-
     a. (Hutchins, 1998): Blow, swell, globular
       i. (Drellishak, 2007): (weakly confirmed) Air, turgid
     b. (Lawler, 1990)
     c. (Rhodes & Lawler, 1981): Color; loud sound
   3. BR-
     a. (Lawler, 1990)
     b. (Rhodes & Lawler, 1981): Discontinuity (e.g., *break, breach, breech, broad, broach, brink, brim*)
   4. CL-
     a. (Hutchins, 1995)
     b. (Hutchins, 1998): Come together, produce noise, result of such an action
       i. (Drellishak, 2007): (strongly confirmed) Together, noise, ringing, collision, sharp, loud, striking, noises
     c. (Rhodes & Lawler, 1981): Together; (sound) Sharp, low pitch onset
     d. (Wallis, 1653): Adherence, retention
   5. CR-
     a. (Hutchins, 1998): Jarring, grating, unpleasant noise
       i. (Drellishak, 2007): (weakly confirmed) noise
     b. (Rhodes & Lawler, 1981): Bent, crooked; (sound) sharp, high pitch onset
   6. DR-
     a. (Hutchins, 1998): Pulling down, restraining, listless quality
       i. (Drellishak, 2007): (weakly confirmed) pulling, slowly, heavy
     b. (Rhodes & Lawler, 1981): Liquid
   7. FL-
     a. (Bergen, 2004)
     b. (Bloomfield, 1933): Moving light, movement in air
     c. (Bolinger, 1950): Movement
     d. (Hutchins, 1995)
     e. (Hutchins, 1998): Extended, continuous, rhythmic motion, motion typical of liquids or gasses
       i. (Drellishak, 2007): (weakly confirmed) move, fan, air, water, ebb, stream
     f. (Rhodes & Lawler, 1981): 2D; inadequate

8. FR-
    a. (Magnus, 2001): Fuzzy/frilly, disintegrate, vulnerable/young, free/congeal, frame/border, nervousness/fear
9. GL-
    a. (Bergen, 2004) : Unmoving light
        i. In Brown Corpus, 38.7% of types and 59.8% of tokens beginning with *gl-* have meanings associated with light or vision.
    b. (Bloomfield, 1933)
    c. (Bolinger, 1950): Light
    d. (Hutchins, 1998): Related to light or vision, visually salient
        i. (Drellishak, 2007): (weakly confirmed) look, light, shine, bright, stare
    e. (Magnus, 2001): Indirect light/seeing, understanding, stickiness
    f. (Marchand, 1960): Light, shine
    g. (Rhodes & Lawler, 1981): Reflected light
    h. (Wallis, 1699)
10. GR-
    a. (Hutchins, 1998): Deep-toned, complaining, threatening noises
        i. (Drellishak, 2007): (weakly confirmed) surly, deep
    b. (Rhodes & Lawler, 1981): Indistinct sound
11. H-
    a. (Rhodes & Lawler, 1981): large
12. J-
    a. (Rhodes & Lawler, 1981): Sharp, sudden (of motions)
13. L-
    a. (Magnus, 2001): Light
14. N-
    a. (Rhodes & Lawler, 1981): 3D
15. P-
    a. (Rhodes & Lawler, 1981): Path along source to a goal: Non-extended.
    b. (Magnus, 2001): Point, pierce, prong, peak. Meanings (relative to /b/ tend to be sharp and hard, less violent and more precise).
16. PL-
    a. (Rhodes & Lawler, 1981): Thick
17. PR-
    a. (Lawler, 1990)
18. R-

    a. (Rhodes & Lawler, 1981) Non-abrupt onset of sounds; around

    b. (Magnus, 2001): The phoneme /r/ in words is associated with walking/running/riding, with 13% of words from this semantic category containing this phoneme (p. 56).

19. SC-/SK-
    a. (Hutchins, 1998): pertaining to surfaces, edges, thinness, superficiality
        i. (Drellishak, 2007): (weakly confirmed) surface, thin, superficially, edge
    b. (Rhodes & Lawler, 1981): 2D extended

20. SCR-/SKR-
    a. (Hutchins, 1998): Unpleasant sounds, irregular movements
        i. (Drellishak, 2007): (weakly confirmed) shrill, shriek, irregular

21. SL-
    a. (Firth, 1930/1964): Pejorative meaning
    b. (Hutchins, 1998): Falling or sliding movement, being pulled down, careless
        i. (Drellishak, 2007): (strongly confirmed) smooth, lazy, negligent, carelessly, smoothly

22. SM-
    a. (Bergen, 2004)
    b. (Firth, 1930/1964): Pejorative
    c. (Hutchins, 1998): Belittling, insulting, pejorative term
        i. (Drellishak, 2007): (unconfirmed)

23. SN-
    a. (Bergen, 2004): In Brown Corpus (Francis & Kučera, 1982), 28.4% of types and 19.0% of tokens have a meaning related to *nose* or *mouth*.
    b. (Bloomfield, 1933)
    c. (Firth, 1930/1964): Pejorative
    d. (Hutchins, 1995)
    e. (Hutchins, 1998): Related to nose, breathing, snobbishness, inquisitiveness
        i. (Drellishak, 2007): (strongly confirmed) nose, contempt, nasal
    f. (Philps, 2011)
    g. (Rhodes & Lawler, 1981): Nose; quick
    h. (Wallis, 1699)

24. SP-
    a. (Genette, 1976/1994): dispersion
    b. (Hutchins, 1998): Bring to point, send out from point, reject

i. (Drellishak, 2007): (strongly confirmed) shoot, emit, jet, out, eject
   c. (Rhodes & Lawler, 1981): Cylinder
25. SPL-
   a. (Hutchins, 1998): Diverge, spread out from a point
        i. (Drellishak, 2007): (weakly confirmed) divide, spatter
26. SPR-
   a. (Hutchins, 1998): radiate from a point or to be elongated
        i. (Drellishak, 2007): (strongly confirmed) shoot, extend
27. SQU-
   a. (Hutchins, 1998): something soft, spongy, squishy, compressed; to constrict, compress, contract, or squeeze something
        i. (Drellishak, 2007): (weakly confirmed) plump, soft
   b. (Rhodes & Lawler, 1981): Compressed
28. ST-
   a. (Firth, 1930/1964): Motor association
   b. (Hutchins, 1998): Something first, upright, regular, or powerful; or forceful linear motion
        i. (Drellishak, 2007): (strongly confirmed) firm, fixed, upright, resolute, obstinate
   c. (Rhodes & Lawler, 1981): 1D Rigid
29. STR-
   a. (Hutchins, 1998): Use of muscles, or forceful action in a line; something linear
        i. (Drellishak, 2007): (weakly confirmed) narrow, force, effort, extend, efforts, line, movement, rigorously
   b. (Rhodes & Lawler, 1981): 2D Flexible
   c. (Wallis, 1653): Strength
30. SW-
   a. (Hutchins, 1998): To oscillate, undulate, or move rhythmically to and fro
        i. (Drellishak, 2007): (weakly confirmed) motion, move
   b. (Rhodes & Lawler, 1981): Path: curved.
31. THR-
   a. (Rhodes & Lawler, 1981): Path: constricted.
32. TR-
   a. (Hutchins, 1998): A path, to walk in a line, locomotion by foot, to step forcefully

                i. (Drellishak, 2007): (weakly confirmed) foot, journey
- b. (Rhodes & Lawler, 1981): Path along source to a goal (unmarked)

33. TW-
- a. (Hutchins, 1998): To turn, distort, entangle, or oscillate; the result of such an action
  - i. (Drellishak, 2007): (weakly confirmed) winding, convolution, spirally, torsion

34. W-
- a. Path: back and forth

35. WR-
- a. (Hutchins, 1998): Irregular motion, to twist, turn, or coil
  - i. (Drellishak, 2007): (weakly confirmed) distorted, distort, twisted, twisting, turn, twist
- b. (Wallis, 1653): Twisting

36. Y-
- a. (Rhodes & Lawler, 1981): Loud vocal tract noises

ii. Phonesthemes: Rime
1. –AB (/æb/)
   - a. (Lawler, 2006): Pejorative, speech
2. –ACK (/æk/)
   - a. (Hutchins, 1998): Collision creating noise or action with abrupt end
     - i. (Drellishak, 2007): (weakly confirmed) noises
   - b. (Lawler, 2006): 2D connected; aural. Words: 47. Coherence: 70%.
3. –AD (/æd/)
   - a. (Lawler, 2006): 2D surface.
4. –AG (/æg/)
   - a. (Lawler, 2006): Crooked/broken; 2D. Size: 39. Coherence: 69%.
5. –AIN/ANE/EIN (/en/)
   - a. (Lawler, 2006)
6. –AM (/æm/)
   - a. (Hutchins, 1998): To restrain something or force into a confined space: something restrained or constrained
     - i. (Drellishak, 2007): (unconfirmed)
   - b. (Lawler, 2006): Contact; aural.
7. –AMP (/æmp/)
   - a. (Hutchins, 1998): To restrain or force to fit in a space; something which restrains or forces to fit in a space
     - i. (Drellishak, 2007): (weakly confirmed) forcibly, crush
   - b. (Lawler, 2006): Contact

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8. –AN (/æn/)
    a. (Lawler, 2006)
9. –ANG (/æŋ/)
    a. (Lawler, 2006): Connected; aural. Words: 27. Coherence: 67%.
10. –ANK (/eŋk/)
    a. (Lawler, 2006)
11. –AP (/æp/)
    a. (Hutchins, 1998): A bounded thing, action, or event, something with a definite or salient end
        i. (Drellishak, 2007): (unconfirmed)
    b. (Rhodes & Lawler, 1981): To use a surface
    c. (Lawler, 2006): 2D (e.g., chap, dap, frap, whap, cap, clap, wrap, slap, strap, flap, lap, map, dapple); contact (clap, frap, slap, strap, cap, dap, whap, wrap, chap, gap, rap, scrap, snap, tap, trap, grapple) Coherence level of 66%. The two senses are not orthogonal.
12. –ARE
    a. (Bolinger, 1950): Intense (e.g., *glare*, *flare*, *tear, blare*)
    b. (Magnus, 2001): Intensity (/r/ in general)
13. –ASH (/æʃ/)
    a. (Hutchins, 1998): Flamboyant, reckless, violent, or destructive action or collision
        i. (Drellishak, 2007): (strongly confirmed) sudden, strike, violently, collision, break
    b. (Lawler, 2006): Violent contact. Words: 25. Coherence: 68%.
14. –ASP (/æsp/)
    a. (Hutchins, 1998): Harsh or grating noise
        i. (Drellishak, 2007): (unconfirmed)
15. –AT (/æt/)
    a. (Tongue) 2d; speech. Words: 53. 64%.
16. –AWL (/ɑːl̩/)
    a. (Hutchins, 1998): Something slow, dragged out, or stretched out
        i. (Drellishak, 2007): (weakly confirmed) slow, creeping, slowly, lengthened, creep
    b. (Lawler, 2006): Multiple senses often present in a word: (1) contact, (2) 2D, (3) motion, (4) expanse, (5) horizontal orientation, (6) vocal image. Second most coherent rime set with an 86% coherence level, 24 of 28 words. Prototypical word is *crawl* or *sprawl*.
17. –AZE
    a. (Lawler, 2006)
18. –EAD/ED (/ɛd/)
    a. (Lawler, 2006): Contact

19. -EAT/EET
   a. (Lawler, 2006): 2D
20. –EEL (/il/)
   a. (Lawler, 2006): 2D motion. Words: 23. Coherence: 65%.
21. –EER/EAR
   a. (Lawler, 2006): Face/eye/nose/ear
22. –END
   a. (Lawler, 2006)
23. –ESS
   a. (Lawler, 2006): 1D crossed. Words: 20. Coherence: 65%.
24. –ICK (/pɪk/)
   a. (Hutchins, 1998): Something sudden, abrupt, or sharp
      i. (Drellishak, 2007): (weakly confirmed) pointed, sharp, point, puncturing, puncture
   b. (Lawler, 2006): Diminutive 3D: concave, convex
25. –IM (/im/)
   a. (Lawler, 2006)
26. –INE (/aɪn/)
   a. (Rhodes & Lawler, 1981): 1D
   b. (Lawler, 2006)
27. –ING (/ɪŋ/)
   a. (Rhodes & Lawler, 1981): To make a sound with an extended envelope (e.g., ring, sing, ding, ping).
   b. (Lawler, 2006): Direct force; Diminutive aural. Words: 32. Coherence: 66%.
28. –INGE (/ɪndʒ/)
   a. (Hutchins, 1998): A sudden or sharp spasm, a contracting or convulsing motion
      i. (Drellishak, 2007): (weakly confirmed) contract, constrict, pinch, sudden, sharp, compress, shrink
29. –INK (/ɪŋk/)
   a. (Lawler, 2006): Diminutive; diminutive oral. Words: 34. Coherence: 74%.
30. –INT ((/ɪnt/)
   a. (Lawler, 2006)
31. –IP (/ɪp/)
   a. (Hutchins, 1998): Quick movement or action
      i. (Drellishak, 2007): (unconfirmed)
   b. (Rhodes & Lawler, 1981): To be slightly off a surface
   c. (Lawler, 2006): (1) Extensions (often small) upward off surface or downward into surface (28 words); (2) diminutive (10 words). Coherence: 78%.
32. –IRL/-URL (/ɚl/)
   a. (Hutchins, 1995)

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      b. (Hutchins, 1998): Something twisted, doubled back on itself, knotted, or intertwines, or an action that produces such a state

          i. (Drellishak, 2007): (weakly confirmed) twist, revolve, eddy, motion, spirals, move

33. –ISK
      a. Rapid motions

34. –ISP
      a. (Hutchins, 1998): A swift, fleeting, or bounded movement or action

          i. (Drellishak, 2007): (weakly confirmed) undulate

35. –IT (/ɪt/)
      a. (Lawler, 2006): Diminutive.

36. –ITTER/-UTTER
      a. (Bolinger, 1950): Intermittent
      b. (Rhodes & Lawler, 1981): Back and forth

37. –IZZ (/ɪz/)
      a. (Lawler, 2006): Separated; dispersed; multiple. Words: 21. Coherence: 76%.

38. –IZZLE
      a. (Rhodes & Lawler, 1981): Produce high range, low amplitude white noise

39. –L
      a. Frequent repetition
      b. (consonant + l in verbs): bizarre states of affairs (Malkiel, 1990)

40. –M
      a. (Magnus, 2001): Beginning of something ongoing (e.g., gleam)

41. –N+Consonant
      a. (Magnus, 2001): A mere suggestion of something (e.g., hint, tint, faint, point, scent, taint, scant, fringe, glance, etc.)

42. –O
      a. (Lawler, 2006): 2D contact.

43. –OAT
      a. (Lawler, 2006): Surface

44. -OB
      a. (Lawler, 2006): Extrusion

45. –OD
      a. (Lawler, 2006)

46. –OIL
      a. (Hutchins, 1998): Pertaining to liquids or to cooking
          i. (Drellishak, 2007): (weakly confirmed) heat

47. –OL
      a. (Lawler, 2006): Round

48. –OLT
   a. (Hutchins, 1998): A powerful, high energy force in motion, often sudden, angular, or violent; or something having energy
      i. (Drellishak, 2007): (weakly confirmed) electromotive, sudden, spring, shake, shock, suddenly
49. –ONE/OAN (/on/)
   a. (Lawler, 2006): Noise
50. –OO/UE/EW/etc. (/u/)
   a. (Lawler, 2006): Liquid/thick. *Stew*, *glue*, and *brew* would be prototypical examples.
51. –OOM (/um/)
   a. (Lawler, 2006): 3D interior/expansion
52. –OOP
   a. (Hutchins, 1995)
   b. (Hutchins, 1998): Curved, concave, or hollow space of thing: or a smooth, swooshing motion tracing such a path
      i. (Drellishak, 2007): (weakly confirmed) bend, dipping
   c. (Lawler, 2006)
   d. (Rhodes & Lawler, 1981): Curved
53. –OP
   a. (Rhodes & Lawler, 1981): Move out of control
   b. (Lawler, 2006)—p. 173: Many of the following senses are present in words: (1) abrupt cessation of motion, (2) ballistic motion, (3) separate/cut, (4) impact, (5) vertical orientation, (6) pejorative, (7) acoustic image, (8) fluid. Lawler says this is the most coherent rime set (87%)—27 of 31 words. The most prototypical word may be *chop*, which combines many senses.
54. –OUCH
   a. (Hutchins, 1998): Something careless, slovenly, or low
      i. (Drellishak, 2007): (unconfirmed)
55. –OUT
   a. (Lawler, 2006): Aggressive contact.
56. –OW
   a. (Bolinger, 1950): Steady (e.g., *glow*, *flow*)
57. –OWL
   a. (Hutchins, 1998): A sinister thing, action, or events
      i. (Drellishak, 2007): (weakly confirmed) threatening
58. –U (/ə/) (Lawler, 2006): Rimes containing this sound tend to be pejorative.
59. –UB (ʌb)

a. (Lawler, 2006): pejorative; 1D thick; diminutive. Third most coherent rime set with 85% coherence, 29 of 34 words.
60. –UFF
   a. (Lawler, 2006)
61. –UG (/əg/)
   a. (Lawler, 2006): Pejorative; fluid, 3D diminutive. Coherence: 77%. Words: 31.
62. –UM (/əm/)
   a. (Lawler, 2006): Pejorative (e.g., scum, slum, bum, dumb, glum, crumb, numb.)
63. –UMP
   a. (Hutchins, 1998): Something heavy, dense, low, or compact; or an action that creates such a state
      i. (Drellishak, 2007): (weakly confirmed) heavy, heavily (* Note that his list also contains numerous words denoting a low arc: e.g., plumper, stub, stumps, lifts, protuberance, leap, and jumping. This is probably closer to the actual sense of the phonestheme.)
   b. (Lawler, 2006): 3D sense; unpleasant people, unpleasant sounds. The sense is said to be highly coherent (85%, or 22 of 26 words). Lawler claims that the two senses are orthogonal. I would disagree with this. The unpleasantness mentioned by Lawler may be regarded as an experiential correlation to moving over an arc (compare some of the senses of the preposition *over*.) It may also be noted that the –UMP nouns converted to verbs tend to have a negative connotation. Compare, for example, the –UMP words in the following: *I was dumped. My card was trumped. We humped it over to the rent-a-car. The two dogs humped.* Further support for the idea that the negative meaning is derived from an experiential correlation comes from the fact that all the derived verbs tend to denote situations in which the difficulty is fairly minor (as one would expect if they had to "jump" over a "bump" or a "hump.") For that matter, the negative sexual connotation in *hump* is also minor.
   c. (Rhodes & Lawler, 1981): 3D
64. –UNK (/əŋk/)
   a. (Lawler, 2006): pejorative; unmelodious noises made by large objects in collision; piece (e.g., chunk, hunk). Coherence: 82%. Size: 22 words.
65. –USH
   a. (Rhodes & Lawler, 1981): along (source to goal)

66. –UST
    a. (Hutchins, 1998): Growth or formation of a surface or projecting from a surface
        i. (Drellishak, 2007): (unconfirmed)
67. –USS
    a. (Lawler, 2006)
68. –UT
    a. (Lawler, 2006)
69. –*V*ng
    a. (Hutchins, 1998): A sharp, quick, or oscillating movement producing a ringing sound or sensation; or the sound produced by such an action
        i. (Drellishak, 2007): (strongly confirmed) sound
70. –*V*nk
    a. (Hutchins, 1998): sharp or quick movement often accompanied by a dull ringing sound; or such a sound
        i. (Drellishak, 2007): (weakly confirmed) sharp, sonorous
71. –*V*sk
    a. (Hutchins, 1998): A brief or fleeting movement or action
        i. (Drellishak, 2007): (unconfirmed)

iii. Phonesthemes: Vowels
1. –EE- (/i/)
    a. Pleasant (C. J. White, 2003)
2. –i- (/I/ as in "chip")
    a. Active (C. J. White, 2003)
    b. Small vs. Korean, in which it's big (Taylor & Taylor, 1962)[37]

iv. Phonesthemes: Frames
1. SP_T
    a. (Hutchins, 1998): Rush of a liquid
        i. (Drellishak, 2007): (weakly confirmed) jet, shoot
2. STR_P
    a. (Hutchins, 1998): A line having breadth
        i. (Drellishak, 2007): (unconfirmed)

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[37] Taylor and Taylor cite this as an example of crosslinguistic differences in sound symbolism. However, the results of their study are not easy to interpret in light of the fact that Korean participants were reading a Korean-language rendering of the words, and both /I/ and /i/ are allophonic in Korean. Even so, it may be mentioned that /i/ also has an association with small size in English, so the contrary finding for Korean represents a clear difference in the sound-symbolic systems of the two languages.

Appendix D

Target Items Used in the Experiment 3 Test
(In the experiment, nonce words are paired with one definition. Depending on the block, the participant sees the target word paired with a definition that is congruent with SS, i.e., the definition given in "a," or with a definition that is incongruent, i.e., that appearing in "b." The example sentence used in the instructional materials is shown in sentence "c." The associated meanings of assonance and rime of each word derived from English phonesthemes are shown in "d").

1. *Blaw1* /blɔl/
    a. Congruent definition: A large swelling.
    b. Incongruent definition: A small cut.
    c. Example sentence: The dog has a *blawl* on its tail.
    d. Associated meaning of assonance and rime: *bl-* (blow, swell) + *-aw1* (something stretched out)

2. *Brap* /bræp/
    a. Congruent definition: A small tear in fabric.
    b. Incongruent definition: Steel supports that hold signs over a highway.
    c. Example sentence: The picture shows a *brap*.
    d. Associated meaning of assonance and rime: *br-* (discontinuity) + *-ap* (surface, contact)

3. *Clisk* /clɪsk/
    a. Congruent definition: To grasp another's hand suddenly in a coordinated motion.
    b. Incongruent definition: Bowing prior to a martial arts match.
    c. Example sentence: After they *clisk*, they begin.
    d. Associated meaning of assonance and rime: *cl-* (together) + *-isk* (rapid motion)

4. *Crad* /cræd/
    a. Congruent definition: A flat piece of metal that has been bent.
    b. Incongruent definition: A shiny metallic box.
    c. Example sentence: The picture shows a *crad*.
    d. Associated meaning of assonance and rime: *cr-* (bent, crooked) + *-ad* (surface)

5. *Dritter* /drɪtər/
    a. Congruent definition: To work slowly with frequent pauses.
    b. Incongruent definition: To work hard with rapid motions.
    c. Example sentence: The boss watched the employee as she *drittered*.
    d. Associated meaning of assonance and rime: *dr-* (slowly) + *-itter* (intermittent)

6. *Flink* /flɪŋk/
    a. Congruent definition: A tiny spark.
    b. Incongruent definition: The long flame produced by a flame-thrower.

     c. Example sentence: The picture shows a *flink*.
     d. Associated meaning of assonance and rime: *fl-* (moving light) + *-ink*
        (diminutive)

7. Glisp /glIsp/
     a. Congruent definition: A short flash of light from a mirror being used to signal
        a plane
     b. Incongruent definition: The long trail left by a mountain bike on a muddy day.
     c. Example sentence: She saw a *glisp*.
     d. Associated meaning of assonance and rime: *gl-* (light or vision) +*-isp* (fleeting)

8. *Grare* /grɛər/
     a. Congruent definition: To complain loudly with curses.
     b. Incongruent definition: To calmly look into the distance.
     c. Example sentence: The woman's *graring*.
     d. Associated meaning of assonance and rime: *gr-* (complaining, threatening
        noise) + *-are* (intense)

9. *Jick* /jɪk/
     a. Congruent definition: To suddenly stab with a sharp object.
     b. Incongruent definition: To threaten someone with a large hand-held weapon.
     c. Example sentence: She jicked him.
     d. Associated meaning of assonance and rime: *j-* (sharp, sudden) + *-ick* (sudden,
        abrupt, sharp)

10. *Plub* /pləb/
     a. Congruent definition: Large and sturdily-built.
     b. Incongruent definition: Small and thin.
     c. Example sentence: I prefer *plub* dogs.
     d. Associated meaning of assonance and rime: *pl-* (thick) + *-ub* (thick)

11. *Scritter* /skrɪt ər/
     a. Congruent definition: To move in awkward zigzag motions.
     b. Incongruent definition: To move in a smooth and graceful manner.
     c. Example sentence: The skater *scrittered*.
     d. Associated meaning of assonance and rime: *scr-* (irregular movements) + *-itter* (back and forth)

12. *Scwum* /skwɜm/
     a. Congruent definition: A mushy inedible gruel.
     b. Incongruent definition: Nicely arranged sliced fruit.
     c. Example sentence: They gave him some *scwum*.
     d. Associated meaning of assonance and rime: *sc-* (superficiality) + *-um*
        (pejorative)

13. *Skack* /skæk/
    a. Congruent definition: To emit a loud sound due to the collision of two hard, flat objects.
    b. Incongruent definition: To emit a hollow sound due to the collision of a long hollow object.
    c. Example sentence: When the boy hit the object against the pavement, it made a *skacking* sound.
    d. Associated meaning of assonance and rime: *sk-* (pertaining to surface, edges) + *-ack* (collision creating noise)

14. Sloop /slup/
    a. Congruent definition: To stand with a non-erect posture as if dejected.
    b. Incongruent definition: To stand with an erect posture as if confident.
    c. Example sentence: The young man slooped.
    d. Associated meaning of assonance and rime: *sl-* (smooth, lazy) + *-oop* (bend)

15. Smab /smæb/
    a. Congruent definition: To make fun of someone.
    b. Incongruent definition: To praise someone.
    c. Example sentence: She smabbed her boss.
    d. Associated meaning of assonance and rime: *sm-* (belittling, insulting) + *-ab* (pejorative, speech)

16. *Snat* /snæt/
    a. Congruent definition: To engage in verbal argument.
    b. Incongruent definition: To dance while swinging one's arms.
    c. Example sentence: The women *snatted*.
    d. Associated meaning of assonance and rime: *sn-* (contempt, snobbishness) + *-at* (tongue, speech)

17. *Snolt* /snoʊlt/
    a. Congruent definition: To suddenly exhale a burst of fire.
    b. Incongruent definition: To glare at someone with a terrifying look.
    c. Example sentence: When the man saw the *snolting* dragon, he fled.
    d. Associated meaning of assonance and rime: *sn-* (quick) + *-olt* (sudden, spring)

18. Spug /spəg/
    a. Congruent definition: To spit out food that tastes bad.
    b. Incongruent definition: To lick one's lips after a fine meal.
    c. Example sentence: The man spugged.
    d. Associated meaning of assonance and rime: *sp-* (eject, emit) + *-ug* (pejorative)

19. *Splare* /splɛər/
    a. Congruent definition: To be ejected at an intense and ever-widening fan-shaped trajectory.
    b. Incongruent definition: To be ejected in a continuous straight line.

    c. Example sentence: It will be hard for the enemy to avoid the *splaring* bullets of this gun.

    d. Associated meaning of assonance and rime: *spl-* (diverge, spread out from a point) + *-are* (intense)

20. *Stolt* /stoʊlt/

    a. Congruent definition: To suddenly leap upward, reaching one's hands into the air so that the body's in a rigid line.

    b. Incongruent definition: To gentle stretch to the side

    c. Example sentence: To get ready for the game, she *stolts*. [A woman crouches down and then thrusts her body in the air so that her body forms a single rigid line.]

    d. Associated meaning of assonance and rime: *st-* (upright, powerful linear motion) + *-olt* (a powerful high energy force in motion)

21. *Swahmp* /swæmp/

    a. Congruent definition: To force into a container using a back-and-forth motion.

    b. Incongruent definition: To roll tightly by kneeling on something.

    c. Example sentence: The boy's *swahmping* his camping equipment.

    d. Associated meaning of assonance and rime: *sw-* (to oscillate, move to and fro) + *-amp* (to restrain or force to fit in a space)

22. *Tware* /twɛər/

    a. Congruent definition: To twist into a tight knot.

    b. Incongruent definition: To roll up loosely.

    c. Example sentence: She's *twaring* the towel.

    d. Associated meaning of assonance and rime: *tw-* (to turn, distort) + *-are* (intensity)

23. *Yit* /yɪt/

    a. Congruent definition: [Animals] To make a faint cry.

    b. Incongruent definition: [Animals] To loudly scrape the ground with feet/hooves.

    c. Example sentence: From behind the bush, he heard an animal *yitting*.

    d. Associated meaning of assonance and rime: *y-* (vocal tract noises) + *-it* (diminutive)

24. *Yolt* /yoʊlt/

    a. Congruent definition: To scream out loudly.

    b. Incongruent definition: To softly hum.

    c. Example sentence: The singer *yolted* a line from the song.

    d. Associated meaning of assonance and rime: *y-* (vocal tract noises) + *-olt* (powerful or violent, or something having energy)

Appendix E
Participant Background Questionnaire

1) Age: _____

2) Gender: M / F

3) Occupation: _____

4) Place of Birth: Korea / U.S. / Other:

5) Have you ever lived in an English-speaking country? (Circle one.)   Yes   No

   If the answer's "yes," how old were you when you lived there? _____

   Also, how long did you live there (how many years and months)?

   _____ years _____ month

6) If you were born in the U.S., what language did you/your family use while you were growing up?

   If you used mainly Korean in the above, when did you start being extensively exposed to English and how? (example: Age 4, attended day care center, or Age 7, attended school, and so on).

7) Please list what percentage of time you have been exposed to Korean and English.
Consider your daily language interaction and what you hear from family, friends, school, community, church, TV, newspaper, etc.

8) What's the highest degree/year of education that you have completed?

9) Self-ratings of English proficiency. Please indicate how well you can carry out the following tasks in English on a scale from 1 to 10.

1	Can order a meal at the restaurant.
2	Can describe my present job, studies, or other major life activities accurately and in detail.
3	Can describe my latest travel experience accurately and in detail.
4	Can sustain everyday conversation in casual style English with my American friend.
5	Can report an event or news that happened around me recently (e.g., a crime report or sports event held recently in your area you live in) in detail.
6	Can describe and discuss the U.S. education system in detail.
7	Can state and support with examples and reasons of my position on a controversial topic (e.g., smoking, birth control, and climate change).
8	Can construct a structured hypothesis on an abstract issue (e.g., globalization and ethnic identity) and discuss the topic knowledgably.
9	Can discuss in detail about cultural difference between Korea and US.
10	Can deliver speech in conferences, lectures, and debates.

Appendix F
Directions for Experiment 1 (Magnitude Sound Symbolism: One Target Word, Two Videos)

<English Version>

Direction:

You will see two identical robots performing different actions. As you watch the robots, you will hear a sentence describing an action. The descriptions will use a word that does not exist in English. You will need to decide which action the word seems to be describing. There is, of course, no right or wrong answer. Simply choose the word that sounds better suited as a word for the action. When choosing the word, trust your instincts and intuition. You don't need to think hard about this as you do it. Let's now try a sample item.

[Sample item is displayed.]

In the audio, you heard, "The robot's feesing." After you watched the robots and heard the sentence, you were asked to choose the robot's action on the left or the right of the screen. "Feesing" isn't a real word, but if it were a real word, which of the actions would it be more likely to describe. If you felt that it is a better word for the action that the robot performs on the left, then you should say "left". If you think it is a better word for the action that the robot performs on the right, then you should say "right". In other words, whenever asked to make a choice, say either "left" or "right" corresponding to your choice. Make sure to respond either "left" or "right" every time you are asked for your choice. Now watch the same animation again. This time, when asked for your choice, say "left" or "right".

<Korean Version>

Direction:

다음은 동일한 두 로보트가 각각 다른 동작을 보여주는 비디오 입니다. 로보트를 보면서 로보트의 동작을 묘사하는 문장을 듣게 됩니다. 그 문장에는 영어에 없는 단어가 있습니다. 그 단어가 어떤 동작을 묘사하는지 결정하십시오. 딱히 옳고 그른 답은 없습니다. 단지 자신의 생각에 비춰 그 동작에 가장 적합하게 들리는 단어를 고르십시오. 단어를 선택할 때는 너무 깊게 생각하지 마시고 감으로 선택하십시오. 이제 보기 문제를 해보십시오.

[보기 항목이 나옴]

오디오에서 "The robot is feesing."이라는 문장을 듣습니다. 로보트를 보고 문장을 들을 때 로보트의 동작이 왼쪽 것인지 오른쪽 것인지 고르라고 합니다. "Feesing"은 실제 존재하는 단어가 아님으로 실제 단어라면 어떤 동작이 그 단어에 더 맞을 지 맞혀봅시다. 그 단어가 왼쪽에 있는 로보트의 동작을 묘사하는 것 같으면 "왼쪽", 오른쪽 로보트의 동작이면 "오른쪽"이라고 하십시오. 다시 말하면, 선택할 때마다 왼쪽 것인지 혹은 오른쪽 것인지 대답하십시오. 이제 에니메이션을 다시 봅시다. 이번에는 선택하라는 지시를 받으면 "왼쪽" 혹은 "오른쪽"이라 답하십시오.

Appendix G
Directions for Exp. 2 (Magnitude Sound Symbolism: One Video, Two Target Words)

<English Version>

Direction:

You will see a robot perform an action. While watching the robot, you will hear one sentence. This is Sentence Number 1. The sentence will contain a word that does not exist in English. You will then hear another sentence with another word that does not exist in English. This is Sentence Number 2. You will then see a screen with a question mark between the numbers. At this point, you should choose either Sentence Number 1 or Sentence Number 2. If you feel that the word in Sentence Number 1 seems like a better word to describe the action that the robot performed, you should respond "one." If you feel that Sentence Number 2 seems like a better word to describe the action the robot performed, you should respond "two". As in the first experiment, you should answer based on your gut feeling and intuition. You do not need to think too much while doing this. Make sure to make one response every time you are asked. Let's now look at a sample item.

[Sample item is displayed.]

While watching the robot, you heard, "The robot is nooming." That was Sentence Number 1. You then heard, "The robot is voding." That what Sentence Number 2. *Nooming* and *Voding* aren't real English words, but if you felt that *Nooming* was a better word for the action the robot was performing, you should say "one" for Sentence Number One. If you felt that *Voding* was a better word for the action that the robot was performing, you should say "two" for Sentence Number Two. Now let's watch the video again. This time, when you see the screen with the numbers one and two with a question mark, respond by saying "one" or "two."

<Korean Version>

Direction:

다음은 동작을 보여주는 로봇입니다. 로봇을 보면서 먼저 첫번째 문장을 듣게 되는데 문장 속에 영어에 실제로 없는 단어가 있습니다 (1 번 문장). 그 다음 문장을 들을 때도 영어에 없는 단어가 있습니다 (2 번 문장). 그 다음 숫자 사이에 물음표가 화면에 나타나면 1 번과 2 번 문장 중에 하나 고르십시오. 1 번 문장 안에 있는 단어가 로봇의 동작을 묘사하는 것처럼 들리면 "하나" 라고 답하고 2 번 문장 안에 있는 단어가 로봇 동작을 묘사하는 것처럼 들리면 "둘" 이라고 답하세요. 그전 실험 에서와 마찬가지로 너무 오래 생각해서 답하지 마시고 감으로 답하세요. 각 문항에는 하나만 답하시기 바랍니다. 이제 보기 항목을 보겠습니다.

[보기 항목이 나옴]

로봇을 볼 때 "The robot is nooming." 이라고 들었습니다. 그것은 1 번 문장이었습니다. 다음으로 "The robot is voding." 이라고 들었습니다. 그것은 2 번 문장이었습니다. Nooming 과 Voding 은 실제로 영어에 없는 단어들입니다. 하지만 이 로봇의 동작을 묘사하는데 *Nooming* 이 더 적합한 단어라 생각하면 "하나" 라고 답하십시오. 혹은 *Voding* 이 더 적합한 단어라 생각하면 "둘"이라고 답하십시오. 이제 비디오를 다시 보겠습니다. 이번에는 1 번과 2 번 그리고 물음표가 스크린에 보입니다. 그럼 "하나 또는 "둘"이라고 답하세요.

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