Production and Comprehension of Time Reference in Korean Nonfluent Aphasia

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Objectives: Individuals with nonfluent agrammatic aphasia show impaired production and comprehension of time reference via verbal morphology. However, cross-linguistic findings to date suggest inconsistent evidence as to whether tense processing in general is impaired or time reference to the past is selectively difficult in this population. This study examined production and comprehension of time reference via verb morphology in Korean-speaking individuals with nonfluent aphasia. **Methods:** A group of 9 healthy controls and 8 individuals with nonfluent aphasia (5 for the production task) participated in the study. Sentence priming production and auditory sentence to picture matching tasks were used, parallel with the previous cross-linguistic experiments in English, Chinese, Turkish, and others. **Results:** The participants with nonfluent aphasia showed different patterns of impairment in production and comprehension. In production, they were impaired in all time references with errors being dominated by substitution of incorrect time references and other morpho-phonologically well-formed errors, indicating a largely intact morphological affixation process. In comprehension, they showed selective impairment of the past, consistent with the cross-linguistic evidence from English, Chinese, Turkish, and others. **Conclusion:** The findings suggest that interpretation of past time reference poses particular difficulty in nonfluent aphasia irrespective of typological characteristics of languages; however, in production, language-specific morpho-semantic functions of verbal morphology may play a significant role in selective breakdowns of time reference.

Keywords: Korean language, Aphasia, Tense, Verb inflection, Time reference

Individuals with nonfluent agrammatic aphasia show difficulty with verbal morphology. In particular, difficulty with tense marking (e.g., *he walked*) has been reported in nonfluent aphasia across many languages, including English (Arabatzi & Edwards, 2002; Clahsen & Ali, 2009; Dickey, Milman & Thompson, 2005; Druks & Carroll, 2005; Faroqi-Shah & Thompson, 2007; Faroqi-Shah & Dickey, 2009; Lee, Milman, & Thompson, 2008), Korean (Halliwell, 2000; Lee, 2000, 2003; cf. Park, Kim, Park, & Shin, 2006), Hebrew (Friedmann & Grodzinsky, 1997), German (Burchert, Swoboda-Moll, & De Bleser, 2005; Wenzlaff & Clahsen, 2004, 2005),

Dutch (Bastiaanse, 2008; Kok, van Doorn, & Kolk, 2007), Greek (Fyndanis, Varlokosta, & Tsapkini, 2012; Nanousi, Masterson, Druks, & Atkinson, 2006; Stavrakaki & Kouvava, 2003; Varlokosta et al., 2006) and others. For example, Lee et al. (2008), using a sentence completion task, found that English-speaking individuals with aphasia have greater difficulty producing finite verbs, in which tense is marked on the main verb (e.g., *he walks*), compared to nonfinite verbs, in which tense is marked on an auxiliary verb (e.g., *he is walking*) (Lapointe, 1985). On the other hand, Faroqi-Shah & Dickey (2009) have shown that English aphasic speakers

have significant difficulty in selecting verb forms in a pre-specified temporal context whether the tense is marked on the main or auxiliary verb (e.g., *Tomorrow* the dog _____. [*will bark, is barking, walked*]).

Despite its pervasiveness, the nature of impaired tense processing remains unclear. A group of researchers have proposed that tense, in general, is impaired in this population. Within recent linguistic theories such as the minimalist program (Chomsky, 1995, 2000), tense is an interpretable (i.e., meaningful) and agreement is an uninterpretable (i.e., marks a grammatical relation within a sentence) feature of the Inflection node. The Tense Underspecification Hypothesis (TUH) claims that in nonfluent agrammatic aphasia the Inflection node is underspecified for tense features due to its interpretability, resulting in errors with tense marking during the feature-checking process (cf. Buchert et al., 2005; Clahsen & Ali, 2009; Nanousi et al., 2006; Wenzlaff & Clahsen, 2004, 2005). Similarly, the Diacritic Encoding and Retrieval Hypothesis (DER; Faroqi-Shah & Dickey, 2009; Faroqi-Shah & Thompson, 2007) suggests that difficulties in tense production arise from the interface between morphology and semantic processes. Based on English-speaking agrammatic speakers' difficulty to select a correct verb form given a pre-verbal temporal adverb in the face of their preserved ability to detect violations of local morpho-syntactic constraints (e.g., *the man will peeling the apple), the DER claims that agrammatic speakers are impaired in selecting and encoding a correct tense feature based on the conceptual-semantic input, whenever temporal processing is required.

Recently, Bastiaanse et al. (2011), based on a cross-linguistic study, proposed that not tense in general, but time reference to the past is affected in nonfluent agrammatic aphasia, coining the Past Discourse Linking Hypothesis (PADILIH). The PADILIH holds that reference to the past, unlike present and future, is discourse linked, requiring formation of an extra-sentential referential relationship between the speech time (the phrase in the sentence) and the event time (a reference outside of the sentence) that do not coincide with each other (Zagona, 2003; Avrutin, 2000 for agrammatic aphasic individuals' impaired discourse linking in other referential structures including reflexive pronouns and *which*-questions). The authors examined production and comprehension of past, present, and future forms in agrammatic individuals from Turkish, Eng-

lish, and Chinese, which express time references through inflectional morphology, both inflectional and periphrastic forms, and free-standing aspectual adverbs, respectively. The results largely supported the PADILIH. Participants with aphasia showed greater impairment with the past than present and future for comprehension in all three languages, and for production in English and Turkish (Abuom & Bastiaanse, 2013 for parallel evidence from Swahili-English bilingual individuals with agrammatic aphasia; Bastiaanse, 2008; Jonkers & de Bruin, 2009 for the evidence from Dutch).

Notably, Chinese participants with aphasia showed equally impaired production of the past, present, and future. Unlike their control participants, they omitted aspectual adverbs consistently because the use of a temporal lexical adverb in the sentence allowed omission of aspectual adverbs. Interestingly, in a later study (Bastiaanse, 2013) the same pattern appeared in Indonesian speakers with aphasia, another language in which time frames can be marked by free-standing aspectual adverbs. Bastiaanse (2013) argued that in Chinese and Indonesian languages, use of temporal aspectual adverbs is optional; that is, they are used only when the time frame is not clear from the discourse context. Hence, no matter what time frame they refer to, production of aspectual adverbs requires discourse syntax to link the event time to the discourse. Since the discourse linking process is impaired in agrammatic aphasia, according to the PADILIH, even non-past forms are difficult to produce for agrammatic speakers in these languages.

While cross-linguistic evidence for impaired verbal morphology in aphasia is increasing, there are clearly at least two issues that need to be resolved. First, given the inconsistent findings in the literature, it needs to be further examined whether temporal processing in general is challenging to individuals with nonfluent agrammatic aphasia or whether the impairment is more specific when referencing past forms. Secondly, provided with the Chinese and Indonesian data that showed different production deficits compared to the rest of the languages examined in Bastiaanse et al. (2011) and Bastiaanse (2013), it remains an open question whether and how language specific morpho-syntactic structures affect processing of time reference differently between production and comprehension modalities. To better understand these questions, the current study examined production and comprehension of time reference in Korean-speaking individuals with nonfluent aphasia.

Korean is an agglutinating language with the base subject-object-verb (SOV) order (Nam & Koh, 2003; Sohn, 1999). A clause in Korean typically ends with a verb suffixed with several grammatical morphemes. As seen in (1), grammatical morphemes such as agreement (e.g., honorific agreement –*si*), tense (e.g., past -*ess*), and mood (sentence types, e.g., plain declarative -*ta*) appear as a conglomerated form with a verb stem. Although other inflectional morphemes are optional, a mood marker should occur at the end of a matrix clause because a bare verb stem is a non-word and cannot stand alone in Korean (Sohn, 1999).

(1) ku pwun-i o-*si-ess-ta*.

The person-nominative come-*honorific agreement-past-declarative*

'The person came.'

Korean has two kinds of tense distinction: past and non-past (An, 1980; Lee, 2001; Lee & Ramsey, 2000; Nam & Koh, 2003; Sohn, 1999). The past tense is marked by the presence of the inflectional morpheme –*(e)ss*, which indicates not only the event occurred earlier than the speech time but also the perfective meaning of the event (example (a) in Table 1). The past tense morpheme –*(e)ss* is always overtly expressed in predicates that indicate a past and/or perfective event and omission of –*(e)ss* results in an ungrammatical utterance.

Non-past tenses are marked by the *absence* of the past marker –*(e)ss*; therefore, it is often realized as a *ZERO* morpheme, referring to either a present or future event depending on the overall temporal context of the discourse. However, non-past tenses can also be overtly expressed via verb inflection or periphrastic structures,

particularly to make the time frame of the utterance more explicit. When overtly marked, the most typical present tense marker is the inflectional bound morpheme –*(nu)n*, suffixed to a lexical verb stem as in (b) in Table 1 (Lee, 2001; Nam & Koh, 2003; Sohn, 1999; and others). Another way of indicating the present time reference, specifically to refer to an action in progress, is through a periphrastic structure as in (c) in Table 1. In this case, the lexical verb 'eat' is not inflected for tense, but the present tense is marked on the auxiliary verb '*iss-* (stay)' with a ZERO morpheme. Although not all linguistic theories differentiate the interpretations of –*(nu)n* and –*ko iss-* (e.g., Lee, 2001; Sohn, 1999), they are different in terms of whether the tense is marked on the main verb or auxiliary verb, similar to the finite (e.g., *eats*) vs. nonfinite (e.g., *is eating*) distinction in English. We refer to these two forms as 'simple present' and 'present progressive', respectively, throughout this paper.

The future time reference, a subtype of non-past tense, can also be overtly expressed using a periphrastic form (–*ul kes i-*). The verb stem is marked by a prospective modal suffix –*(u)l* followed by a nominal marker *kes* ('fact') and the auxiliary copula verb *i-* ('be') as in the example (d) in Table 1 (Sohn, 1999). To summarize, Korean past tense is marked by an obligatory inflectional morpheme –*(e)ss*, while non-past tenses are usually unmarked. When the time reference is unclear from the discourse context, non-past forms can be overtly expressed via verb inflectional or periphrastic forms.

In the present study, we examined production and comprehension of past, present, and future forms in Korean-speaking individuals with aphasia. Specifically, this study focused on individu-

Table 1. Verb morphology for time reference in Korean

	Verb morphology	Tense	Refers to
(a)	*Namja-ka ecey sakwa-lul meok-**ess**-ta.* man-Nom yesterday apple-Acc eat-PAST-Plain. 'Yesterday the man ate an apple.'	Past	Past
(b)	*Namja-ka maeil sakwa-lul meok-**nun**-ta.* man-Nom everyday apple-Acc eat-PRES-Plain 'Everyday the man eats/is eating an apple.'	Non-past	Present
(c)	*Namja-ka jigeum sakwa-lul meok-**ko iss-ZERO**-ta.* man-Nom now apple-Acc eat-Comp stay-PRES-Plain. 'Now the man is eating an apple.'	Non-past	Present
(d)	*Namja-ka apeuro sakwa-lul meok-**ul kes** i-ta* man-Nom in the future apple-Acc eat-PRS fact be-Plain. 'In the future the man will eat an apple.'	Non-past	Future

Nom = nominative case; Acc = accusative case; PRES = present; Comp = complementizer; PRS = prospective modal; Plain = plain declarative ending.

als with nonfluent aphasia whose speech is characterized by disfluent speech with reduced grammatical complexity, given that most research on tense processing has centered on nonfluent (or agrammatic) aphasia. It was asked whether our Korean speakers with nonfluent aphasia have a selective deficit with past, compared to non-past forms, or whether they are impaired in tense processing overall. The TUH and DER suggest that tense is impaired due to underspecified tense features or impaired diacritic encoding; thus, they do not predict any dissociation among different verb forms. On the other hand, the PADILIH suggests that individuals with nonfluent aphasia are impaired in processing time reference to the past via grammatical morphology due to its increased demands for discourse-linking. Hence, the past time reference is expected to be more impaired than those that refer to the present and future.

METHODS

Participants

Eight individuals with stroke-induced nonfluent aphasia (4 females, 4 males; age: mean 57.2 years, ranged 49-79 years; education: mean 11.3 years, ranged 6-16 years; post onset stroke: mean 11.2 months, ranged 6-16 months) and 9 age-matched controls (4 females, 5 males; age: mean 58.9 years, ranged 47-75 years; education: mean 11.9, ranged 6-16 years) served as participants. Participants with aphasia were recruited from Asan Medical Center and Bobath Memorial Hospital, and control participants were recruited from Seoul and Gyeonggi areas in South Korea. All participants with aphasia suffered from a left cerebral vascular accident with a minimum post onset of 6 months. Control participants were matched to the participants with aphasia in terms of age ($t(15) = .364$, $p = .721$) and education ($t(15) = 337$, $p = .741$). All participants reported normal or corrected-to-normal vision and hearing. None of the participants experienced speech-language difficulties, neurological, or psychological disorders prior to their stroke or participation in the study.

The diagnosis of nonfluent aphasia was based on the participants' performance on the Korean Western Aphasia Battery (K-WAB; Kim & Na, 2001) and spontaneous speech as well as overall language profiles judged by two speech-language pathologists

Table 2. Aphasic participants' performance on the Korean Western Aphasia Battery

Participant	Fluency	Auditory comprehension	Repetition	Naming	Aphasia quotient
A1	4	6.1	4.6	5.1	53.5
A2	5	7.4	5.8	5.3	52.9
A3	4	6.6	3.9	7.1	55.1
A4	5	9.3	9.1	4.8	66.4
A5	4	5.8	4.6	3.2	51.1
A6	4	8.6	8.8	8.2	71.1
A7	4	6.1	1.1	2.3	33.0
A8	4	6.7	2.7	2.5	39.8
Mean	4.3	7.1	5.1	4.8	52.9
SD	0.5	1.3	2.8	2.1	12.5

(Table 2). All participants showed disfluent telegraphic speech marked by reduced morpho-syntactic complexity and a reduced number of propositional phrases in picture description of the K-WAB (fluency score 5 or less) and spontaneous speech. Their auditory comprehension was more preserved than their verbal output, as indicated by an auditory comprehension score higher than a fluency score on the K-WAB as well as functional ability to follow task instructions and conversations.

Materials and Procedure

The production task

Based on the Test for Assessing Reference of Time (TART; Bastiaanse, Jonkers, & Thompson, 2008), a Korean version of the TART was developed (Bastiaanse et al., 2011 for a detailed description of the task). A set of 8 pairs of transitive action verbs was selected from the verbs used in the original TART (Appendix 1 for the stimuli). The verbs in each pair shared a common object, for example, *to pour/drink the milk and to eat/peel the apple*. Using a within-item design, the selected verbs were examined in a set of four verb forms, i.e., past, simple present, present progressive, and future as shown in Table 1. Each verb was repeated twice, once as a prompt and once as a target, resulting in a total of 16 trials for each target verb form. Although both the simple present and present progressive forms refer to a present event, we included these two forms because in the present progressive, the tense is marked on the auxiliary verb with a *ZERO* morpheme, while the tense is marked on the main verb stem with an inflectional marker *–(nu)n* in the simple present tense.
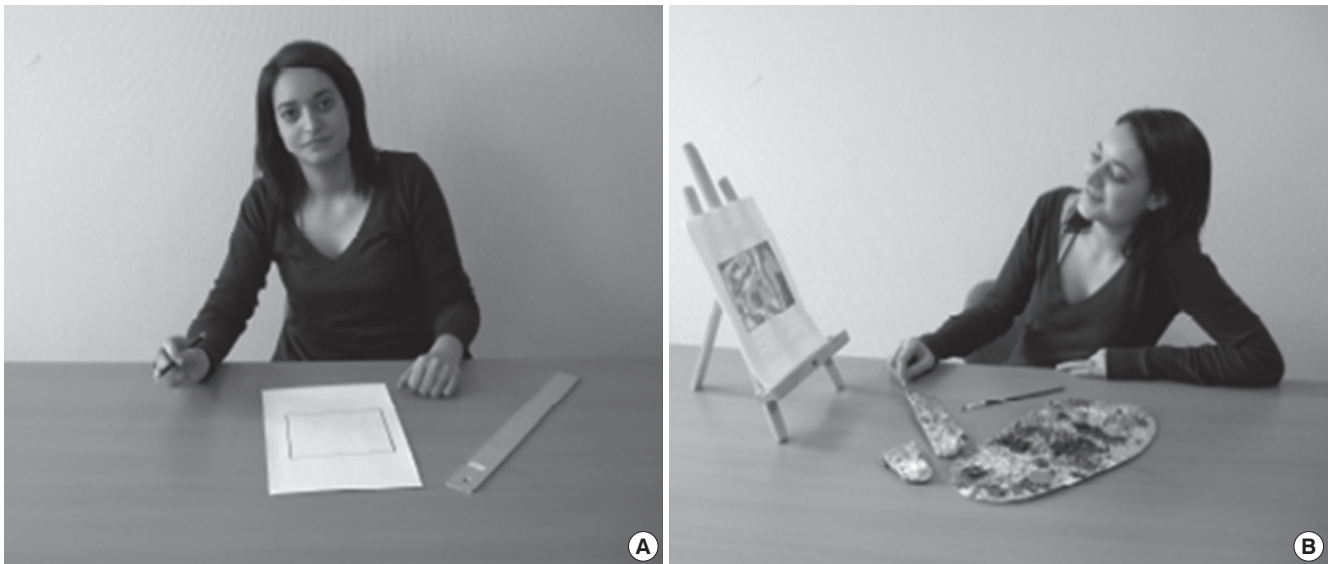
Figure 1. A sample trial for production. (A) The prime sentence is *yeoja-ka ecey keurim-ul keuri-ess-ta* 'yesterday, the woman drew a picture'. (B) The target sentence is *yeoja-ka ecey keurim-ul chilha-ss-ta* 'yesterday the woman painted a picture'.

Colored photographs (used in the original TART) depicting sequences of actions in three pictures were used to elicit target verb forms: one in which the action is yet to take place (used for the future form, e.g., a man holding an unpeeled apple); one in which the action is in progress (used for the simple present and present progressive forms, e.g., a man peeling an apple); and one picture in which the action had been finished (used for the simple past, e.g., a man holding a peeled apple). To further obligate the production of the target verb forms, different temporal adverbs were used: i.e., *apeuro* 'in the future', '*jikeum* 'now', *maeil* 'everyday', and *ecey* 'yesterday', for the future, present progressive, simple present, and past tense, respectively.

A sentence priming production paradigm was used to elicit the target verb forms. For each trial, participants were presented with a pair of pictures. The neutral verb forms (verb stem + plain declarative ending -*ta*) were provided in writing to minimize confounding effects from verb retrieval deficits of participants with aphasia (Figure 1). The examiner produced a prompt sentence with a targeted verb form. Then, the target sentence was introduced with a lead-in structure and the participant was asked to complete the sentence with a correct verb form. A set of eight practice trials preceded the experimental trials. No feedback regarding the accuracy of the responses was provided during the experimental trials. The examiner repeated the prompt sentence once when requested

by the participant. Production of the target verb form was scored as correct. Given that the participant was provided with a targeted verb form, substitution of the present progressive form for the simple present form or vice versa was considered as incorrect. No time limit was given in the participant's response and the last attempt was scored when the response was self-corrected by the participant. When incorrect responses occurred, error types were tallied into substitution, omission, and 'other' errors.

The comprehension task

A picture to spoken sentence matching task was used to examine comprehension of the past, simple present, and future forms. No temporal adverbs were used in the sentence stimuli, unlike the production task. The participant was presented with a pair of pictures (Figure 2) and asked to point to the picture that matched the sentence produced by the examiner. The sentence was repeated once when requested by the participant. No time limit was given in the participant's response. For self-corrected trials, the final response was scored.

RESULTS

Production results

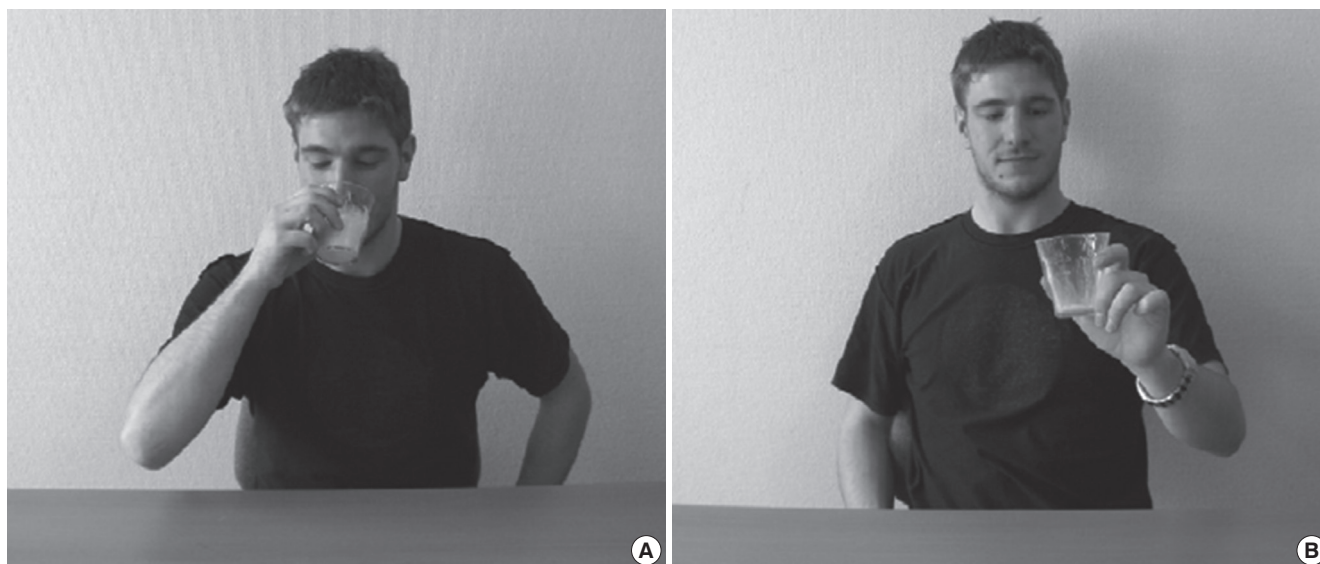Figure 3 shows the results from the production task (Appendix

Figure 2. A sample trial for comprehension. Target sentence is *namja-ka uyu-lul mas-ess-ta* 'the man drank milk'.
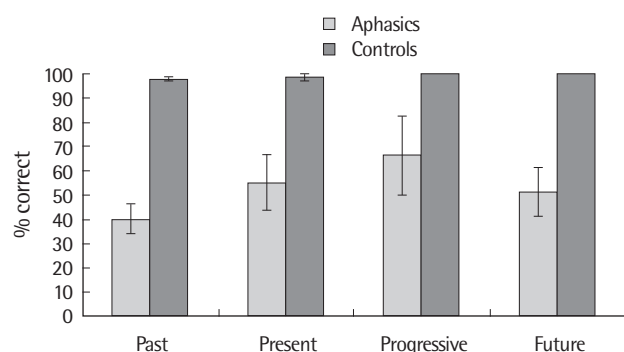

Figure 3. Production accuracies (with standard errors).

Table 3. Summary of error types (number of errors) produced by participants with aphasia

Error type	Past	Present	Progressive	Future	Total
Substitution					
Time frame	21	15	8	9	53
Other	6	4	9	9	28
Omission	18	8	10	13	49
Non-word	4	1	2	8	15

2 for individual performance). Three participants with aphasia were excluded from the production task due to production of significantly unintelligible responses (A6), hypophonia (A8), and inability to complete the task (A7), resulting in a total of five participants. All control participants (n = 9) completed the production task. Between-group comparisons revealed that participants with aphasia performed significantly worse than control participants in all verb forms examined (*p*'s < .007, Mann-Whitney tests).

Within-group analyses revealed that for control participants, there was no main effect of verb forms, indicating that they showed ceiling performance in all forms (past = 98%, simple present = 99%, present progressive = 100%, and future = 100%; $\chi^2(3) = 4.714$, *p* = .194). For participants with aphasia, there was no main effect of verb forms: they performed poorly in all conditions (past = 40%,

simple present = 55%, present progressive = 66%, and future = 51%; $\chi^2(3) = 2.020$, *p* = .568). Although the present progressive resulted in a numerically higher mean accuracy than the rest of the verb forms, pair-wise comparisons using Wilcoxon Signed Ranks tests revealed no reliable differences between the verb forms produced (all *p*'s > .221, Wilcoxon signed rank tests). Individual data patterned with the group results: only 2 out of 5 participants with aphasia showed numerically lower accuracy in past compared to non-past forms (Appendix 2).

Table 3 summaries the number of error types produced by participants with aphasia. Overall, the most frequent error type was substitution of non-target verb forms, including substitution of a different *time frame* and *other* inflectional forms. Time reference substitution errors, i.e., production of non-target time reference, were common across the verb forms (e.g., 'is pulling/will pull' for 'pulled'; 'pulled/ will pull' for 'pulls/is pulling'; 'pulled/ is pulling' for 'will pull'). *Other* substitution errors consisted of various 'mor-
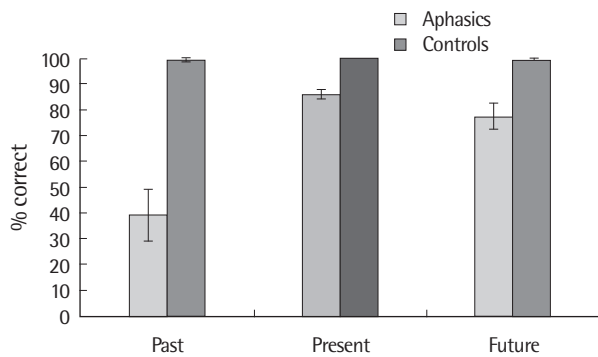
Figure 4. Comprehension accuracies (with standard errors).

pho-phonologically well-formed' substitutions, including addition of an auxiliary verb (e.g., *meok-ko-sip-ess-ta* 'wanted to eat' for *meok-ess-ta* 'ate'), substitution of a main verb (e.g., *sse-ul kes-i-ta* 'will write' for *keuri-l kes-i-ta* 'will draw'), and responses with multiple errors (e.g., *chilha-ko-sip-ta* 'wants to paint' for *chilha-ss-ta* 'painted'). Although less frequent than substitution errors, the aphasic participants also produced omission errors consisting of 'verb stem+declarative marking *-ta*' such as *meok-ta* ('to eat'). Notably, our aphasic participants produced very few morpho-pho-nologically ill-formed errors, resulting in non-word responses (e.g., *kkeul-e iss-ta* for *kkeul-ko iss-ta* 'is pulling'; *keurim-ta* for *keuri-l kes i-ta* 'will draw').

Comprehension results

Figure 4 shows the results from the comprehension task. Between-group comparisons revealed that participants with aphasia showed significantly lower accuracies than control participants in all verb forms (*p*'s < .002, Mann-Whitney tests). For control participants, parallel to their production results, there was no main effect of verb forms because they showed ceiling performance across conditions (past = 99%, present = 100%, future = 100%; χ^2(2) = 1.00, *p* = .607). For participants with aphasia, different from their production results, there was a main effect of verb form (χ^2(2) = 7.548, *p* = .023). Pair-wise comparisons using Wilcoxon signed ranks tests revealed that participants with aphasia showed significantly lower accuracy in past (39%) compared to present (86%; Z = 2.431, *p* = .025) and future (77%, Z = 2.383, *p* = .017) forms. However, the difference between the present and future was not reliable (Z = 1.380, *p* = .168). Individual data indicated that 7 out of 8 par-

ticipants with aphasia showed greater difficulty with past than non-past forms (Appendix 2).

DISCUSSION & CONCLUSION

There has been growing research focused on understanding the nature of verbal morphology deficits in nonfluent aphasia across languages. This study examined production and comprehension of time reference via verbal morphology in Korean-speaking individuals with nonfluent aphasia. Based on the two opposing theoretical positions in the literature, we tested whether or not Korean participants with aphasia experience greater difficulty with reference to the past compared to present and future as predicted by the PADILIH (e.g., Bastiaanse, 2008; Bastiaanse et al., 2011; Yabay & Bastiaanse, 2009) or whether or not they are impaired in all verb forms involving tense processing as predicted by the TUH and DER (Faroqi-Shah & Dickey, 2009; e.g., Wenzlaff & Clahsen, 2004, 2005). Using the Korean version of the TART (Bastiaanse et al., 2008), a sentence priming production task and an auditory sentence to picture matching task were used. Interestingly, our Korean participants with aphasia showed different patterns of performance between production and comprehension: they were equally impaired in producing all verb forms; however, they showed greater difficulty comprehending past as compared to present and future verb forms. We discuss the comprehension data first.

The results from the comprehension task are consistent with the PADILIH (Bastiaanse et al., 2011). The PADILIH suggests that time reference to the past is selectively impaired in agrammatic speakers because reference to the past requires processing by discourse linking (involves processing of extra-sentential relationships between the speech time and event time), whereas reference to the present and future do not. Our participants with aphasia showed poorer performance than control participants in all verb forms; however, they were significantly more impaired on the past tense, compared to present and future forms. Our findings are, therefore, consistent with the findings from other languages using the TART in Chinese, English, Turkish, and Dutch (Bastiaanse et al., 2011) and bilingual Swahili-English nonfluent agrammatic speakers (Abuom and Bastiaanse, 2013; Abuom, Obler, & Bastiaanse, 2011). This parallel pattern of cross-linguistic evidence in

comprehension of time reference is indeed interesting and suggests that in spite of different morpho-syntactic structures used to mark time reference across languages, individuals with nonfluent agrammatic aphasia are impaired in interpreting time reference to the past. The proposals that suggest that temporal processing in general is impaired in nonfluent aphasia (Faroqi-Shah & Dickey, 2009; e.g., Wenzlaff & Clahsen, 2005) would be too broad to account for the dissociation between past vs. non-past forms shown in these cross-linguistic data, including Korean.

Contrary to the comprehension results, in the production task, our participants with aphasia did not show selective impairment of past; rather, they performed poorly in all verb forms examined. The past tensed verb form did not elicit significantly more errors compared to the non-past (simple present, present progressive, and future) forms and there was no difference among the non-past forms. Individual participants showed variously impaired performance across different verb forms and only 2 out of 5 participants with aphasia showed seemingly lower scores in past than in non-past forms. In addition, within the present forms, whether the tense is marked on the main verb ('simple present') or on the auxiliary verb ('present progressive'), the difference was not reliable, resulting in only numerically increased accuracy for the present progressive. The lack of selective impairment between different time frames are in line with the previous findings that tense in general is impaired in nonfluent agrammatic aphasia (Faroqi-Shah & Dickey, 2009; Friedmann & Grodzinsky, 1997; Wenzlaff & Clahsen, 2004, 2005). Further, our data suggest that irrespective of the position of the tense within the verb predicate, i.e., on the lexical verb or auxiliary verb, participants with aphasia have difficulty producing correct verbal morphology to indicate time frames (Clahsen &Ali, 2009; Faroqi-Shah & Dickey, 2009).

Error analysis also sheds light on the nature of the deficit in our Korean participants with aphasia. More substitution errors were produced than omission or non-word errors across the board. The substitution errors consisted of incorrect time frame errors and non-target verb inflection forms that followed correct morpho-phonological constraints. These data suggest that the process of morpho-phonological affixation per se remains largely intact in Korean speakers with aphasia, consistent with dominant substitution errors seen in speakers with aphasia from other languages (Bas-

tiaanse, 2008; Faroqi-Shah & Thompson, 2007; Lapointe, 1985; Lee et al., 2008; Menn & Obler, 1990). The error patterns, together with the production and comprehension data, also suggest that while our participants with aphasia are sensitive to local morpho-syntactic well-formedness constraints in the verb predicate structure, the difficulties may arise from a higher level morpho-semantic deficit such as impaired selection or encoding of appropriate time reference or tense features (Faroqi-Shah & Dickey, 2009; Faroqi-Shah & Thompson, 2007; Fyndanis et al., 2012; Lee et al., 2008; Wang, Yoshida, & Thompson, in press).

The current findings also complement previous studies on verb inflection in Korean. Lee (2000, 2003) and Halliwell (2000), examining impairment and sparing of various functional categories, have shown that tense marking on lexical verbs is difficult to produce and comprehend (Lee, 2003) in speakers with nonfluent aphasia. Park et al., (2006) reported that past and present tenses are more preserved than future tense; however, it is unclear if this is specific to nonfluent aphasia because they tested a group of participants with fluent and nonfluent aphasia (Bos, Brederoo, & Bastiaanse, 2011; Kljajevic & Bastiaanse, 2011 for different impairment patterns or error types in participants with fluent aphasia). Our study suggests that beyond the finiteness of lexical verbs, tense marking through periphrastic forms can also be affected in Korean individuals with nonfluent aphasia and interpretation of the past time frame via verbal morphology is particularly vulnerable in this population at least in the comprehension modality.

An important question that is worth exploring is why our Korean participants with aphasia are impaired in producing all verb forms in the face of selective impairment of the past in comprehension. This lack of selective impairment in production could simply be due to the morpho-syntactic variations in Korean non-past forms, as discussed in the introduction. For example, the present event can be expressed by the *ZERO* morpheme, inflectional morpheme *-(nu)n* or the periphrastic form *-ko iss-*, depending on grammatical and discourse contexts. The same holds true for the future. While a future event can be overtly expressed via a periphrastic form, when a temporal context is clear, either *ZERO* morpheme or the inflectional marker – *(nu)n* can be used as in *nae-il keu-ka tteona-ZERO-yo/tteona-n-ta* (tomorrow he-Nom leave-PRES-polite/leave-PRES-plain 'tomorrow he will leave'). There-

fore, unlike the past tense marker –*(e)ss*, non-past tenses are rather complex in terms of their morphological variations and distributions. Although we obligated the production of the target verb forms by providing a sentence model in addition to a picture stimulus, the variability of the non-past forms might have inflated the difficulty to select one form to use in our speakers with aphasia (Menn & Obler, 1990; Park et al., 2006).

An alternative and perhaps theoretically more stringent account is that Korean non-past forms are discourse-linked in the same way as the past tense *when overtly encoded and expressed* and are, therefore, difficult to produce. Bastiaanse et al. (2011) and Bastiaanse (2013) showed that in Chinese and Indonesian, speakers with aphasia were also equally impaired in producing aspectual adverbs to express past, present, and future time references. These two languages differ from Korean in that they use free-standing aspectual morphology. However, in all three languages, overt marking of grammatical morphology is optional (non-past morphemes only in Korean and both past and non-past morphemes in Chinese and Indonesian), meaning that they are used to specify a referential relationship between the event time and the discourse when this 'linking' is not clear (Bastiaanse, 2013, for a more detailed argument). Thus, it can be postulated that in languages in which grammatical morphology is optionally marked for time reference, when they are overtly expressed, their production involves processing of discourse linking, resulting in increased difficulty for speakers with aphasia.

It should be made clear that we are not suggesting that discourse linking is intrinsic to 'optional' grammatical morphemes; rather, the process of producing them renders the morphemes to be associated with discourse syntax. In the comprehension task, when our participants with aphasia interpreted the relation of temporal entities (e.g., event time, speech time) based on a *given* verbal morphology in a sentence, they showed selective difficulty comprehending the past, compared to present and future. The same was true in Chinese and Indonesian participants with aphasia as well as the other languages in which verbal temporal morphology is always overtly marked (e.g., English, Turkish, and Dutch). Considering these findings together, it can be suggested that interpretation of grammatical morphology referring to the past may require greater processing demands compared to that referring to present

and future tense morphology because it involves discourse linking. In addition, the same grammatical morphemes involving time reference can be impaired or spared depending on its function, i.e., whether it is used for discourse-linking or not, at least in languages which allow optional marking of temporal grammatical morphology.

Admittedly, the current study is not without limitations and the aforementioned proposals are still preliminary, requiring further testing. There exist many cross-linguistic findings that do not pattern with our findings, possibly exacerbated by different structures and tasks examined between languages as well as modalities, including our own. Therefore, further research is warranted examining how different typological characteristics influence breakdowns of time reference in individuals with aphasia. Methodologically, given that the findings from this study are based on single sentence-based tasks and a relatively small number of participants with aphasia, examining production and comprehension of time reference in tasks involving multiple sentence relations and in a larger sample may yield more revealing evidence on time reference in aphasia. Lastly, we tested only participants with nonfluent aphasia given that most previous cross-linguistic studies have centered on time reference in nonfluent aphasia and impaired verbal morphology has long been associated with agrammatic features of nonfluent aphasic speech. However, a few recent studies have shown that difficulty with tense processing may be present in fluent aphasia, although it is unclear whether or not their underlying disorder is the same with that of nonfluent aphasia (Jonkers & de Bruin, 2009; Kljajevic & Bastiaanse, 2011). Therefore, examining time reference in fluent aphasia is needed to better elucidate whether selective impairment with the past is specific to nonfluent aphasia.

To conclude, the present study examined the production and comprehension of time reference to the past, present, and future via verb morphology in Korean individuals with nonfluent aphasia. Our individuals with aphasia showed different patterns of impairments between the production and comprehension modality. In production, they were impaired in all time frames whether it is done through an inflectional marker of a lexical verb or a periphrastic structure. Further, their errors were mainly time reference substitutions and other morpho-phonologically well-formed substitution errors. These data suggest that impaired time reference in

our Korean individuals with nonfluent aphasia goes beyond the finiteness of lexical verbs and is likely to arise from a higher level of morpho-semantic deficit with morpho-phonological affixation processes remaining largely intact. In comprehension, our Korean participants with aphasia showed selective impairment of past, compared to present and future forms, consistent with the cross-linguistic evidence shown in Bastiaanse et al. (2011). Collectively, the current findings suggest that interpretation of past time reference may pose particular difficulty in nonfluent aphasia irrespective of linguistic typologies; however, in production, language-specific morpho-syntactic structures may play a more significant role in the breakdown of time reference.

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Appendix 1. List of the stimuli (object+verb) used in the TART-Korean (with English translation)

편지를 읽다/쓰다 (practice trial)	to read/write the letter (practice trial)
우유를 마시다/따르다	to drink/pour the milk
상자를 채우다/비우다	to fill/empty the box
수레를 밀다/끌다	to push/pull the wagon
그림을 칠하다/그리다	to paint/draw the picture
종이를 찢다/붙이다	to tear/glue the paper
바닥을 닦다/쓸다	to mop/sweep the floor
옷을 다리다/개다	to iron/fold the sweater
사과를 깎다/먹다	to peel/eat the apple

TART=Test for Assessing Reference of Time.

Appendix 2. Performance of individual participants with aphasia (% correct)

Participant	Production task				Comprehension task		
	Past	Present	Progressive	Future	Past	Present	Future
A1	19	63	13	50	25	100	69
A2	56	63	100	31	19	88	88
A3	31	50	81	44	31	94	75
A4	50	88	100	94	81	94	100
A5	44	13	38	38	44	94	75
A6	-	-	-	-	19	94	75
A7	-	-	-	-	69	44	63
A8	-	-	-	-	25	81	75

국문초록

비유창성 실어증 환자의 시제표시 이해와 산출 능력

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배경 및 목적: 많은 언어권에서 비유창성 실어증 환자는 동사시제의 산출과 이해에 어려움을 보인다고 보고되었다. 그러나 모든 시제에서 어려움을 보이는지, 혹은 특정 시제의 처리에 선택적으로 더 심한 어려움을 보이는지에 대해서는 언어권마다 다른 연구 결과를 보이고 있다. 본 연구에서는 한국 비유창성 실어증 환자를 대상으로 동사시제의 산출과 이해능력을 살펴보았다. 방법: 8명의 실어증 환자가 이해 과제에, 그 중 5명이 산출 과제에 참여하였다. 9명의 정상인이 통제군으로 실험에 참여하였다. 동작이 다른 두 장의 그림을 제시하고, 검사자가 앞의 그림에 해당하는 문장 모델을 말하고 피험자에게 뒤의 그림에 적합한 동사시제를 산출하도록 하였다. 이해과제로는 그림-문장 매칭 과제가 사용되었다. 결과: 산출 과제에서 실어증 환자들은 모든 시제에서 어려움을 보였으며, 시제 간의 차이는 보이지 않았다. 오류는 시제의 대체와 기타 형태음운론적으로 적합한 대체오류가 주를 이루었다. 이해 과제에서는, 다른 언어권의 결과와 동일하게 과거시제에서 더 심한 어려움을 보였다. 논의 및 결론: 본 연구 결과는 한국어 비유창성 실어증 환자의 동사시제 산출과 이해의 어려움이 동사어미의 형태-음운론적 활용 자체보다는, 형태-의미론적 기저에서 발생하는 것임을 보여준다. 또한 과거시제의 이해처리가 언어간 차이와 무관하게 실어증 환자들에게 어려우나, 언어 간 문법적 특성이 시제 형태소 산출 장애에서는 중요한 역할을 할 수 있으며, 보다 정확한 장애의 근본 기제 이해를 위해서는 향후 언어 간 비교 연구가 필요하다.

핵심어: 비유창성 실어증, 시제표시, 동사 시제, 언어 간 연구