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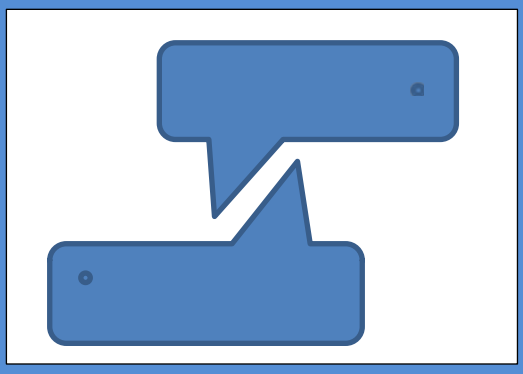

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Table of Contents

Articles

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Facilitatory effect of vowels on retroflex stop production in Malayalam speaking children with Down syndrome

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Abstract

Speech and language development is often delayed in children with Down syndrome (DS) Reduced speech intelligibility is one of the major concerns in children with DS. Phonological intervention approaches have proved to be effective in improving the speech intelligibility in this population. Selecting appropriate stimulus hierarchy is crucial in any intervention program. Hence it is recommended to proceed from a facilitating to less facilitating vowel context to increase the pace of learning in children with speech sound errors including DS. Retroflex phonemes are the late acquiring phonemes in Malayalam and these are the most misarticulated phonemes. The aim of the present study was to investigate the effect of vowels in facilitating the correct production of retroflex stops in children with DS whose native language is Malayalam. Three boys with DS in the age range of 5-10 years with mild to moderate intellectual disability served as the participants for the study. The participants misarticulated either or both of the retroflex stop cognates (/ʈ/ or /ɖ/). Using phonetic placement the participants were trained on words with target phoneme in various vowel contexts and positions (initial and medial). Ten sessions of articulation therapy was provided for each phoneme for each participant. The accuracy of responses across the therapy sessions were calculated and graphically analyzed. The vowel context in which the participants were able to produce the phoneme with greater than 80% accuracy in most number of sessions was considered as the facilitating context. The results revealed that the unvoiced retroflex /ʈ/ was most facilitated by vowel /a/ and /o/ in word initial position and /u/ in word medial position. The voiced retroflex stop /ɖ/ was facilitated in the context of /o/ in word initial position and /u/ in the word medial position.

Keywords: Down syndrome, Vowel context, Retroflex, Malayalam, Contextual facilitation.

1. Introduction

Down syndrome (DS) is the most common genetic cause of intellectual disability. The cognitive phenotype of DS is characterized by a disproportionate deficiency in language development as opposed to social intelligence (Chapman, Seung, Schwartz, & Kay-Raining Bird, 1998). A significant delay in both speech and language is seen in individuals with DS (Abbeduto & Haggerman, 1997; Dodd, 1975; Kumin, 1996), even then the language skills especially receptive language is considerably better than their speech skills (Rondal & Edwards 1997). A number of investigations on speech and language of individuals with intellectual disability have reported

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that articulatory/phonological problems are particularly severe for children with Down syndrome (Blanchard, 1964; Dodd, 1975, 1976; Dodd, Leahy& Hambly, 1989; Rosenberg & Abbeduto, 1993; Stoel Gammon, 1981). Apraxia of speech has also been reported in DS (Rupela & Manjula, 2007). Such phonological/articulatory errors have a negative impact on speech intelligibility which is further documented as a major concern of parents and caregivers of individuals with DS (Kumin, 1994; Pueschel & Hoppmann, 1993; Toğram, 2015). This emphasizes the need to target speech intelligibility of children with DS during speech and language intervention. However, speech-language pathologists and educators working with children and adults with Down syndrome have focused less on problems with speech and its intelligibility during intervention programs (Kumin, 1986)

Most of the intervention programs for remediating the speech sound errors individuals with DS have focussed on increasing the phonetic repertoire and reducing the number of errors in single word productions, using therapy techniques similar to those for children with phonological delays or disorders. Only two treatment studies have been reported in the literature, and both have indicated that a phonological approach positively affects speech intelligibility. In the first study, Cholmain (1994) described a therapy programme for young children with Down syndrome (4; 1 - 5; 6 years) that focused on listening and practising production of selected phonemes. A 6-14 week therapy program resulted in significant improvement in percentage of consonants correct scores. In the second study, Dodd, McCormack and Woodyatt (1994) conducted a 12-week parent directed treatment program focussing on reducing the variability in word productions. The children demonstrated improved speech intelligibility post-treatment and produced fewer deviant and developmental errors. From the previous research, it was evident that the speech intelligibility of children with DS improves with intervention but their learning pace was reported to be slow. Shriberg and Widder (1990) argued that correction of the articulatory errors should be a mandatory goal during the intervention of children with DS, though the progress is slow and the resources are limited. Improving speech intelligibility will enhance the social and vocational placement of individuals with intellectual disability. This stresses the need to consider numerous factors while designing intervention goals for children with DS.

One such factor is the selection of appropriate stimuli. In the early stages of articulation training, the therapist needs to formulate multiple lists of syllables, words, phrases, and sentences which the clients can discriminate and produce easily and successfully. Another major variable affecting articulatory proficiency is the phonetic environment (Curtis & Hardy, 1959; Gallagher & Shriner, 1975a, b). The production of any phoneme is influenced by the neighbouring phonemes and this is termed as coarticulation. Adjacent phonemes can either facilitate or inhibit correct

articulation of a target sound. That is, certain phonetic environments or linguistic conditions are more likely than others to be associated with the correct production of a phoneme. Hence the management should proceed from facilitative contexts to less facilitative or non-facilitative contexts.

The effect of vowel context in facilitating the production of speech sounds have been reported in many case studies in the past. Stringfellow and McLeod (1994) carried out a case study on a 5 year old English speaking boy with language delay, who substituted /l/ for /j/ and found that vowels /i/ and /a/ facilitated the production of glide /j/. Lancaster and Pope (1989) recommended that the post-alvoelar placement and lip rounding gesture of post-alveolar fricative can be achieved by pairing it with vowels like /u/ with similar articulatory gestures. In a case study, Stokes and Griffiths (2010) reported that back vowels facilitated the production of palatal fricative /ʃ/, in a seven year old monolingual boy with post-alvoelar fronting of fricative /ʃ/. Results also highlighted that selection of vowel context was custom-made to suit the child's needs. Similarly, back vowels facilitated the production of velar phonemes in English speaking children with speech sound disorder in the age range 5-to 7-years (Cleland, Scobbie & Wrench, 2015).

In India, similar studies were carried out in two Dravidian languages spoken in the southern part of the country, namely Kannada and Malayalam. The first attempt was made by Krishna and Manjula (1991). They reported that the production of retroflex /ʈ/ was facilitated in the context of vowels /a/ and /i/ for a 15 year old male with misarticulation of /ʈ/ in Kannada. For Kannada, the retroflex phonemes /ʈ/, /ɖ/ and /ɳ/ were facilitated by vowel /u/ followed by /i/ and /a/ as seen in a case study of children with speech sound disorder (Amulya & Sreedevi, 2018). In Malayalam, a case study on facilitative vowel context for production of velar phonemes in children with hearing impairment revealed vowel /a/ facilitated the production of both voiced and unvoiced velars whereas /e/ was the least facilitating context in Malayalam (Anu Rose & Sreedevi, 2017). Developmental evidences also suggest preferential occurrence of /a/ with bilabials followed by dentals, high front vowel /i/ with /t, j, c, h/ and high back vowel /u/ with /p, b, k/ in children in the age range of 12-24 months (Alphonsa & Sreedevi, 2012; Irfana & Sreedevi, 2012).

From the past evidence, it is quite established that the neighbouring vowels can facilitate the correct production of phonemes. Thus training the misarticulated phonemes in facilitating vowel contexts is expected to enhance the learning pace in individuals with speech sound errors including those with DS. However it is essential to build evidences for various commonly misarticulated phonemes and also across different languages as

the phonotactic rules of languages are known to differ. Malayalam[3] is a Dravidian language with unique phonological characteristics which is widely spoken in the south Indian state of Kerala. The phoneme inventory of Malayalam language is vast with distinct place and manner of articulations and has 5 stops and 6 nasals (Ladefoged & Maddieson, 2001). Retroflex phonemes are considered as the most difficult and late acquiring phonemes in Malayalam (Divya & Sreedevi, 2010). Malayalam retroflexes have more complex tongue movements than dentals and velars as reported by ultrasound imaging studies. Also the angle between the slope of the surface of the anterior tongue body and tongue blade is reduced, indicating a greater degree of tongue curling typical of a subapical post alveolar retroflex articulation in Malayalam (Sindhusha, Irfana & Sreedevi, 2014). Retroflex is the most misarticulated place of articulation in children with DS in Malayalam (Anitha & Sreedevi, in press). Hence the present study aimed at investigating the vowel contexts that facilitate the production of retroflex stops in Malayalam speaking children with DS.

2. Methodology

The study was approved by the ethics committee for bio-behavioural research projects involving human subjects, All India Institute of Speech and Hearing, Mysore, India. The ethical guidelines by Basavaraj and Venkatesan (2009) were followed during the study. Informed written consent was obtained from parents of the participants before recruiting for the study.

2.1. Participants

Three Malayalam speaking boys with Down syndrome with a mean age of 9 years 7 months with misarticulation of either or both of the retroflex stops - /ʈ/ and /ɖ/served as the participants of the study. All of them had mild to moderate degree of intellectual disability as indicated in the disability certificate issued by the government of Kerala. The participants were included considering that they had no co morbid problems like autism, cerebral palsy and seizure or any severe behavioural problems. The demographic details of the participants are as shown in Table 1.

[3] "Malayalam is a Dravidian language primarily spoken in the southwest of India. According to Lewis (2009), it is the official language of Kerala state and Lakshadweep Union territory. Within India alone there are 35 million speakers of Malayalam according 2011 census of India, not including the other nearly 5,00,000 speakers outside India. Malayalam has 11 monophthongs and 2 diphthongs and 52 consonantal phonemes, encompassing 9 places of articulation which are bilabial, labiodental, dental, alveolar, alveolo-palatal, retroflex, palatal, velar, and glottal and 8 manners of articulation which include plosive, nasal, trill, tap/flap, fricative, affricate, central approximant, and lateral approximant (Haowen Jiang, 2010)".

Table 1.

Demographic details of the participants

Participant No	CA (in years and months)	IQ	Language age (in months)		Speech sound errors with substitution
			RLA	ELA	
S1	10; 7	60	42-48	36-42	t/ʈ, d/ɖ
S2	8; 4	50	36-42	30-33	t/ʈ
S3	10; 5	70	42-48	36-42	t/ʈ, d/ɖ

**CA-chronological age, IQ-Intelligence Quotient, RLA-Receptive Language Age, ELA-Expressive Language Age.*

2.2. Study design

The current research adapted a case study method to investigate the effect of vowel context (independent variable) in facilitating the production of retroflex stops (dependent variable). The learning of target phonemes were monitored across different vowel contexts before, during and after the of articulation therapy. Although case studies exhibit limitations concerning generalization, replication, and researcher bias, this method was chosen as they provide rich qualitative information guiding additional insights in the field of research (McLeod, 2013).

2.3. Materials

To study the effect of vowels in facilitating the production of retroflex phonemes in Malayalam, two separate wordlists were prepared for intervention and assessment for the two target phonemes (/ʈ/ and /ɖ/). The production of phonemes was taught in different vowel contexts using the intervention wordlist and the generalization of the learning was assessed using the assessment wordlist. Meaningful bisyllabic/trisyllabic picturable words familiar to children were selected and the wordlists were prepared with the target phonemes occurring in the initial and medial positions in the context of different vowels. The prepared wordlist was rated for familiarity by two speech-language pathologists and a special educator on a 3 point rating scale. The words rated as familiar and most familiar by at least two of the judges were selected and final wordlists were prepared.

The intervention wordlist consisted of a total of 43 words (/ʈ/-22 words & /ɖ/ -21 words). The vowel contexts considered for unvoiced /ʈ/ in initial position were /a/, /i/, /u/, and /o/and medial position were /a/, /i/, /u/ and /o/. For the voiced /ɖ/ the contexts considered were /a/, /i/, /u/and /o/in the word initial position and /a/, /i/, /u/ and /e/in the word medial position. Few examples of the stimuli are given in Appendix I and the number of stimuli in each vowel context is given in Appendix II. The

assessment wordlist consisted of one word each in the vowel context and phoneme position as considered in the intervention wordlist. Hence a total of 16 words were included in the assessment wordlist.

2.4. Procedure

2.4.1 Assessment

The articulatory abilities of the children were assessed using Malayalam Diagnostic Articulation Test-Revised (Neenu & Sreedevi, 2010; Vipina & Sreedevi, 2010; Vrinda & Sreedevi, 2010). It is a single word articulation test developed to assess the acquisition of speech sounds in Malayalam for children in the age range of 3-6 years. Repetition task was employed to elicit responses from the participants and the articulatory errors were documented. The assessment wordlist was administered on the first, fifth and tenth sessions of therapy to document the generalization of learning.

2.4.2. Intervention

For each phoneme, the participants received ten sessions of articulation therapy of 30 minutes duration twice or thrice in a week. For participant 1(S1) and participant 3 (S3), who had misarticulation of both /ʈ/ and /ɖ/, the unvoiced /ʈ/ was taught first. Phonetic placement approach was employed to teach the phonemes at word level. The intervention wordlist was used to drill the correct production of target phonemes in different vowel contexts. The pictures with the orthographic forms were presented on a 14 inch Dell Inspiron 14 R laptop screen using Microsoft PowerPoint 2017. The words were presented twice in random order to the participants and the participants attempted the word five times during each presentation. The first response of each presentation was considered to calculate the accuracy of responses. A phoneme was considered to be learnt when the participant produced it correctly for 80% of times. The vowel context in which the criterion was met for most number of sessions was considered as the facilitating context. Facilitating context was established in both initial and medial positions.

2.4.3. Data analysis

The data were analyzed graphically as the sample size was small. In a single case design statistical significance does not give transparent, equivocal experimental control over the behaviour (Kazdin, 1976). Intra-and inter-judge reliability was calculated for percentage correct response scores across first, fifth and tenth sessions using Cronbach's Alpha using SPSS software version17.

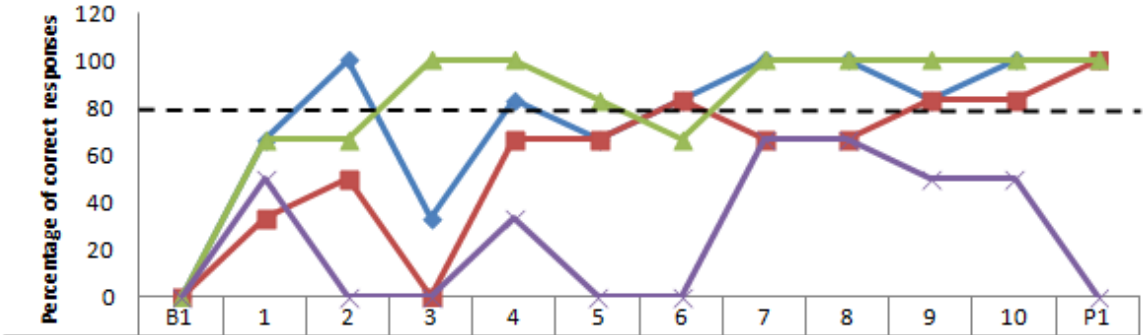
3. Findings

The intra-judge reliability for percentage of correct responses was 0.831 and the inter-judge reliability was 0.812 indicating good reliability. The effect of vowel context in facilitating the production of retroflex stops (/ʈ/ and /ɖ/) in

children with DS in Malayalam was studied in the word initial and medial position. The performances of the participants on the intervention wordlist across ten sessions and the pre therapy (B1) and post therapy baselines (P1) using the assessment wordlist are as shown in Figure 1 to 10. A phoneme was considered to be learnt in a vowel context if the accuracy of child's production is more that 80% and this is indicated using a dotted line in the graph.

3.1 Effect of vowel context on unvoiced retroflex stop /ʈ/

For the unvoiced retroflex stop /ʈ/, the vowel contexts considered in the word initial position were /a/, /i/, /e/ and /o/ and in the word medial position, /a/, /i/, /u/ and /o/ as per the phonotactics of Malayalam. All the three subjects had error in production of /ʈ/. The performances of the participants across the ten sessions are as shown in figures 1 to 6.



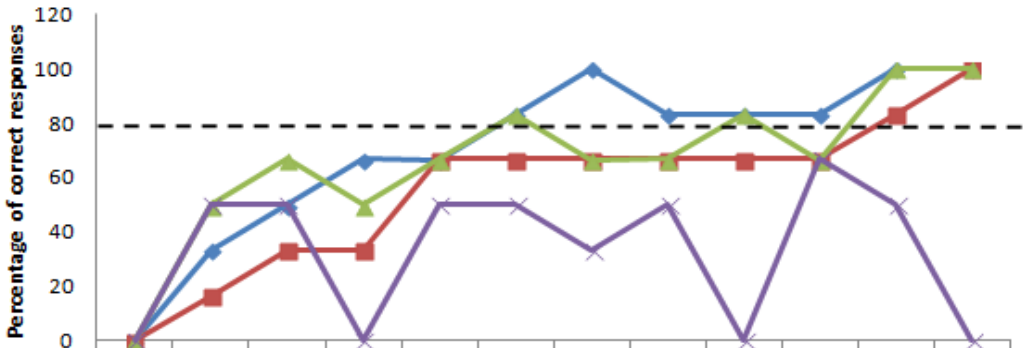
	B1	1	2	3	4	5	6	7	8	9	10	P1
/ʈa/-I	0	66.667	100	33.333	83.333	66.667	83.333	100	100	83.333	100	100
/ʈi/-I	0	33.333	50	0	66.667	66.667	83.333	66.667	66.667	83.333	83.333	100
/ʈo/-I	0	66.667	66.667	100	100	83.333	66.667	100	100	100	100	100
/ʈe/-I	0	50	0	0	33.333	0	0	66.667	66.667	50	50	0

(/ʈa/-I: /ʈ/ in the context of vowel /a/ in initial position; /ʈi/-I: /ʈ/ in the context of vowel /i/ in initial position; /ʈu/-I: /ʈ/ in the context of vowel /u/ in initial position; /ʈe/-I: /ʈ/ in the context of vowel /e/ in initial position. B1- Pretherapy baseline; P1- Post therapy baseline)

Figure 1: Percentage of correct response of unvoiced retroflex /ʈ/ production across vowel contexts of participant 1 (S1) in word initial position

Figure 1 shows the performance of participant 1 (S1) during the production of unvoiced retroflex /ʈ/ in the initial position. The vowel /o/and /a/ faciliated the production of /ʈ/ as the accuracy of production was greater that 80% in seven sessions out of ten sessions in both of the contexts. However the consistency of production was better for /o/ when compared to /a/. Hence /o/ facilitated the production of /ʈ/better. /ʈ/was least facilitated in the context of /e/as the accuracy of production never reached the criterion and the variability in production was high. The performance of

participant 2 (S2) during the production of unvoiced retroflex /ʈ/ in the initial position was similar to S1, hence Figure 2 is given in appendix III.

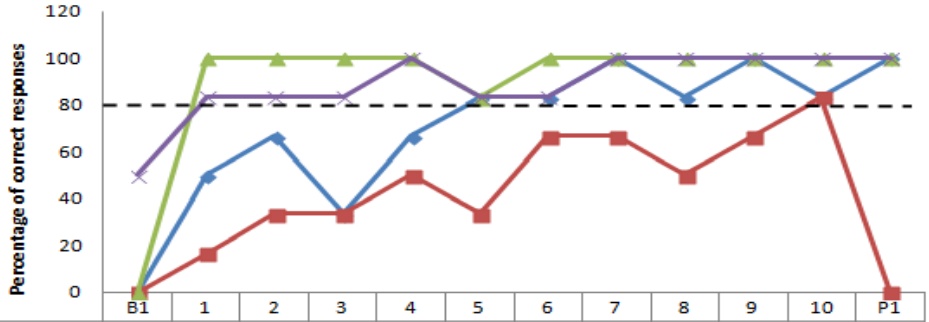


	B1	1	2	3	4	5	6	7	8	9	10	P1
/ʈa/-I	0	33.333	50	66.667	66.66	83.333	100	83.33	83.33	83.33	100	100
/ʈi/-I	0	16.667	33.333	33.333	66.667	66.667	66.667	66.667	66.667	66.667	83.333	100
/ʈo/-I	0	50	66.667	50	66.667	83.333	66.66	66.667	83.333	66.66	100	100
/ʈe/-I	0	50	50	0	50	50	33.333	50	0	66.667	50	0

(/ʈa/-I: /ʈ/ in the context of vowel /a/ in initial position; /ʈi/-I: /ʈ/ in the context of vowel /i/ in initial position; /ʈu/-I: /ʈ/ in the context of vowel /u/ in initial position; /ʈe/-I: /ʈ/ in the context of vowel /e/ in initial position. B1- Pretherapy baseline; P1- Post therapy baseline)

Figure 3. Percentage Correct Response of unvoiced retroflex /ʈ/ production in the context of various vowels of participant 3 (S3) in word initial position

The performance of participant 3 (S3) during the production of unvoiced retroflex /ʈ/ in the initial position is as shown in figure 3. Here /a/ facilitated the production of /ʈ/ as the criterion of 80% was met in six sessions. As seen in S1, /e/ was the least facilitating context for the production of /ʈ/.



	B1	1	2	3	4	5	6	7	8	9	10	P1
/ʈa/-M	0	50	66.66	33.33	66.66	83.33	83.33	100	83.33	100	83.33	100
/ʈi/-M	0	16.66	33.33	33.33	50	33.33	66.66	66.66	50	66.66	83.33	0
/ʈu/-M	0	100	100	100	100	83.33	100	100	100	100	100	100
/ʈo/-M	50	83.33	83.33	83.33	100	83.33	83.33	100	100	100	100	100

(/ʈa/-M: /ʈ/ in the context of vowel /a/ in medial position; /ʈi/-M: /ʈ/ in the context of vowel /i/ in medial position; /ʈu/-M: /ʈ/ in the context of vowel /u/ in medial position; /ʈo/-M: /ʈ/ in the context of vowel /o/ in medial position. B1- Pretherapy baseline; P1- Post therapy baseline)

Figure 4: Percentage Correct Response of unvoiced retroflex /ʈ/ production in the context of various vowels of Subject 1 (S1) in word medial position

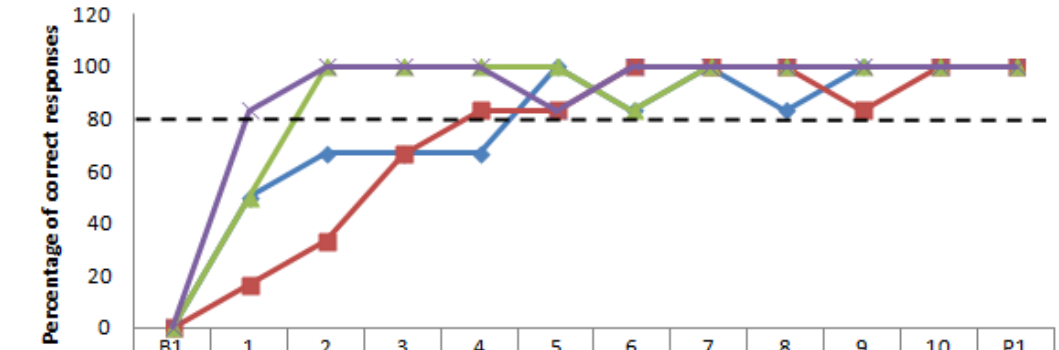
Figure 4 shows the performance of S1 in the production of /ʈ/in the word medial position. The vowels/u/ and /o/ facilitated the production of /ʈ/in

medial position. The accuracy criteria of 80% was met in all the ten therapy sessions by S1 in both /u/ and/o/ contexts. The performance of S2 and S3 were also similar to this, hence the graphs (figure 5 & figure 6) depicting their performance are given in Appendix III.

To conclude, in the word initial position, vowel /o/ facilitated the correct production of /ʈ/ participant 1 (S1) and participant 2 (S2), whereas for participant 3 (S3) it was /a/. In the word medial position the high back vowel /u/ facilitated the production of /ʈ/ in all the three participants.

3.2 Effect of vowel context on voiced retroflex stop /ɖ/

For the voiced retroflex stop /ɖ/, the vowels considered in the initial position were /a/, /i/, /u/ and /o/ and in the medial position were /a/, /i/, /u/ and /e/. The participants S1 and S3 had misarticulation of /ɖ/. The performances of the participants across the ten sessions are as shown in figures 7 to10.

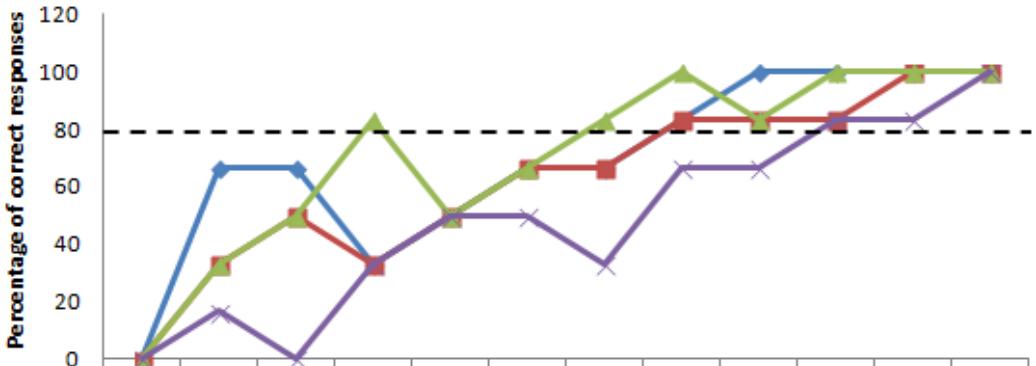


	B1	1	2	3	4	5	6	7	8	9	10	P1
/ɖa/-I	0	50	66.66	66.66	66.66	100	83.33	100	83.33	100	100	100
/ɖi/-I	0	16.66	33.33	66.6	83.33	83.33	100	100	100	83.33	100	100
/ɖu/-I	0	50	100	100	100	100	83.33	100	100	100	100	100
/ɖo/-I	0	83.33	100	100	100	83.33	100	100	100	100	100	100

(/ɖa/-I:/ɖ/ in the context of vowel /a/ in initial position; /ɖi/-I: /ɖ/ in the context of vowel /i/ in initial position; /ɖu/-I: /ɖ/ in the context of vowel /u/ in initial position; /ɖo/-I: /ɖ/ in the context of vowel /o/ in initial position. B1- Pretherapy baseline; P1- Post therapy baseline)

Figure 7. Percentage Correct Response of retroflex /ɖ/ production in the context of various vowels of participant 1 (S1) in word initial position

Figure 7 shows the performance of S1 during the production of /ɖ/in initial position. As observed in the graph, the context /o/ and /u/ facilitated the production of /ɖ/ as the accuracy criterion was met in ten and nine sessions respectively in these vowel contexts. The performance of S3 also showed a similar trend of /o/ facilitating the production of /ɖ/. Hence the graph depicting the performance of S3 (Figure 8) is given in Appendix III.



	B1	1	2	3	4	5	6	7	8	9	10	P1
/ɖa/-M	0	66.66	66.66	33.33	50	66.66	66.66	83.33	100	100	100	100
/ɖi/-M	0	33.33	50	33.33	50	66.66	66.66	83.33	83.33	83.33	100	100
/ɖu/-M	0	33.33	50	83.33	50	66.66	83.33	100	83.33	100	100	100
/ɖe/-M	0	16.66	0	33.33	50	50	33.33	66.66	66.66	83.33	83.33	100

(/ɖa/-M: /ɖ/ in the context of vowel /a/ in medial position; /ɖi/-M: /ɖ/ in the context of vowel /i/ in medial position; /ɖu/-M: /ɖ/ in the context of vowel /u/ in medial position; /ɖe/-M: /ɖ/ in the context of vowel /e/ in medial position. B1- Pretherapy baseline; P1- Post therapy baseline)

Figure 9: Percentage Correct Response of retroflex /ɖ/ production in the context of various vowels by Subject 1 (S1) in word medial position

Figure 9 shows the performance of S1 during the production of /ɖ/in medial position. From the figure it can be observed that /u/ facilitated the production of /ɖ/in medial position and the accuracy criterion was met in six sessions out of ten sessions of articulation therapy. Similar trend was observed in S3 as well. Hence the graph depicting the performance of S3 (Figure 10) in the production of /ɖ/is given in Appendix III.

To conclude, the voiced retroflex stop /ɖ/ was facilitated in the context of /o/ in the initial position and in the context of /u/ in the medial position for all the participants.

4. Discussion

In the present study, all the three participants considered had misarticulation of unvoiced /ʈ/ and two had misarticulation of voiced /ɖ/. The overall trend in facilitating vowel contexts were similar across participants but individual differences were observed in terms of the hierarchy of facilitating contexts. The graphical analysis showed that the vowels /a/ and /o/ facilitated the production of /ʈ/ in word initial position and vowel /u/ in the word medial position. In case of voiced retroflex stop /ɖ/, vowel /o/ facilitated the production in word initial position and vowel /u/ in the word medial position.

The facilitative effects of consonant-vowel pairing are believed to be due to the maintenance of an articulatory gesture from one segment to the next, as

neuromuscular demands are organized for initiation prior to the segment for which they are required (Clark, Yallop & Fletcher, 2007). Hence a vowel with similar articulatory gesture to that of the target phoneme can facilitate its accurate production. In the current study, vowel /o/facilitated the production of unvoiced retroflex /ʈ/ for two of the participants (S1 & S2) and voiced retroflex/ɖ/ in both the participants (S1 & S3) in the word initial position. The high back tongue positioning of /o/ is compatible to that of the subapical post alveolar tongue position of retroflex stop and hence facilitated its production. Vowel /a/ facilitated the production of /ʈ/ in S3 in word initial position. Ultrasound imaging studies reported that the extent of coarticulation of vowel /a/ on retroflex stops is the least when compared to /u/ and /i/ (Irfana & Sreedevi, 2017). It implies that /ʈ/ has higher coarticulation with vowel /a/ and the articulatory gestures of the two phonemes are compatible. This could be the reason for the unvoiced retroflex stop /ʈ/ being faciliated by vowel /a/ in one of the participants in the current study. Similar findings were reported in Kannada by Amulya and Sreedevi (2018).

In the word medial position, the high back vowel /u/ facilitated the production of both /ʈ/ and /ɖ/ for all the participants. Physiological studies on coarticulation using ultrasound imaging showed that coarticulation of retroflex phonemes are high in the context of /u/and the retroflex can influence /u/ in such a way that the tongue dorsum moves instead of tongue root during its production (Irfana & Sreedevi, 2017). So it can be stated that the articulatory gestures for back vowels like /u/ and /o/ are less interfering with tongue tip movement required for retroflex production and hence facilitating. This facilitatory effect of back vowels in the production of retroflex stops have been reported in other languages as well (Amulya & Sreedevi, 2018).

Another reason could be the restricted tongue tip movements seen in children with DS that might interfere with the production of retroflex phonemes. The additional demands of tongue tip movement required for production of front vowel /i/ might compromise the accuracy of retroflex production in this population. So the articulatory gesture for back vowels /u/ and /o/ will be less interfering with retroflex production in DS and hence facilitating.

The findings of the current study are not in agreement with the observation of Krishna and Manjula (1991) where vowels /i/ facilitated the production of unvoiced retroflex /ʈ/. This difference could be attributed to the difference in the population studied and age of participants. The participant in the former study was a 15 year old male with misarticulation with no associated

co-occurring disability whereas in the present study it was children with Down syndrome.

Although the findings of the study is in agreement with the previous studies, variability in the hierarchy of facilitating contexts across participants have been observed. Hence individual differences should be considered while implementing the same for therapeutic intervention.

5. Conclusion

Reduced speech intelligibility is one of the major concerns in children with Down syndrome. As the learning pace in this population is slow, it is recommended to adopt methods that would ease their learning. Facilitating vowel contexts can be utilized to teach phonemes in an efficient way. The results of the current study revealed that the production of retroflex stops /ʈ/ and /ɖ/ in Malayalam were facilitated in the context of vowel /u/ in word medial position. In the word initial position it was vowels /a/ and /o/ for /ʈ/ and /o/ for /ɖ/.

The sample size considered for the present study is small, hence replication of the study in larger number of subjects is recommended. It can also be replicated in other disordered populations with speech sound errors such as hearing impairment, apraxia of speech etc. Studies are also warranted in different languages as coarticulation is language specific to a large extent.

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Appendices

Appendix I

Examples of target words considered for intervention.

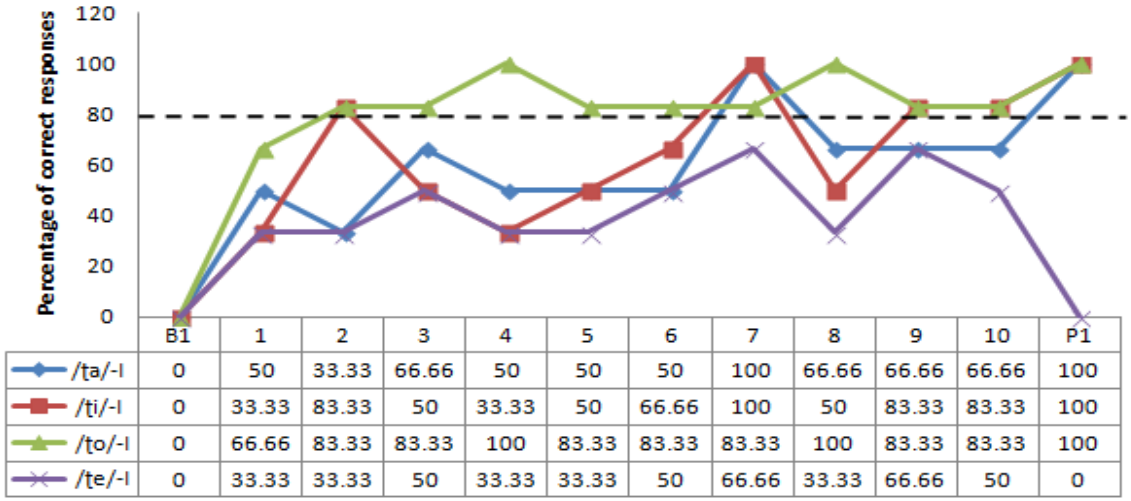
Target phoneme	Initial		Medial	
	Target Word	**Meaning**	**Target Word**	**Meaning**
/ʈ/	/**ʈa**jaɽ/	Tyre	/mu**ʈʈa**/	Egg
	/**ʈi**:vi/	Television	/ku**ʈʈi**/	Child
	/**ʈo**:p/	Dress	/ca**ʈʈu**gam/	Spatula
	/**ʈe**biḷ/	Table	/o:**ʈʈo**/	Auto rickshaw
/ɖ/	/**ɖa**:ns/	Dance	/ku**ɖa**/	Umbrella
	/**ɖi**:sel/	Diesel	/a**ɖi**/	Slap
	/**ɖu**:ɖu	Cartoon character	/la**ɖu**/	A sweet
	/**ɖo**:ɽa/	Cartoon character	/ivi**ɖe**/	Here

Appendix II

Number of stimulus words considered in each of the phonetic contexts and word positions in intervention wordlist.

Phoneme	Initial					Medial				
	/a/	**/i/**	**/u/**	**/e/**	**/o/**	**/a/**	**/i/**	**/u/**	**/e/**	**/o/**
/ʈ/	3	3	-	2	3	3	3	3	-	2
/ɖ/	3	2	2	-	3	3	3	3	3	-

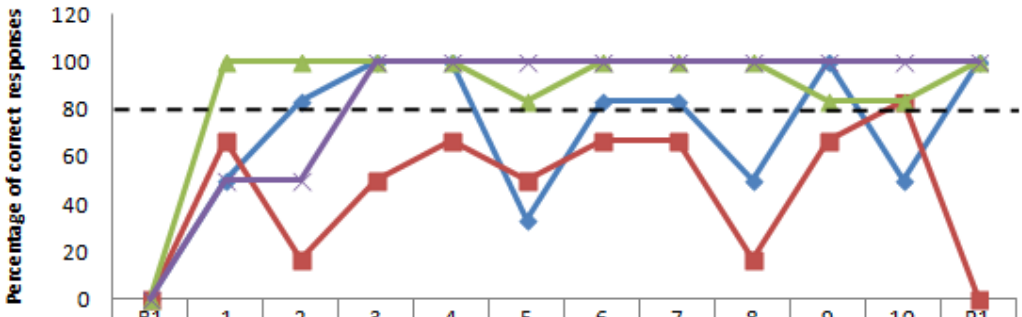
Appendix III (Figures)



	B1	1	2	3	4	5	6	7	8	9	10	P1
/ʈa/-I	0	50	33.33	66.66	50	50	50	100	66.66	66.66	66.66	100
/ʈi/-I	0	33.33	83.33	50	33.33	50	66.66	100	50	83.33	83.33	100
/ʈo/-I	0	66.66	83.33	83.33	100	83.33	83.33	83.33	100	83.33	83.33	100
/ʈe/-I	0	33.33	33.33	50	33.33	33.33	50	66.66	33.33	66.66	50	0

(/ʈa/-I: /ʈ/ in the context of vowel /a/ in initial position; /ʈi/-I: /ʈ/ in the context of vowel /i/ in initial position; /ʈu/-I: /ʈ/ in the context of vowel /u/ in initial position; /ʈe/-I: /ʈ/ in the context of vowel /e/ in initial position. B1- Pretherapy baseline; P1- Post therapy baseline)

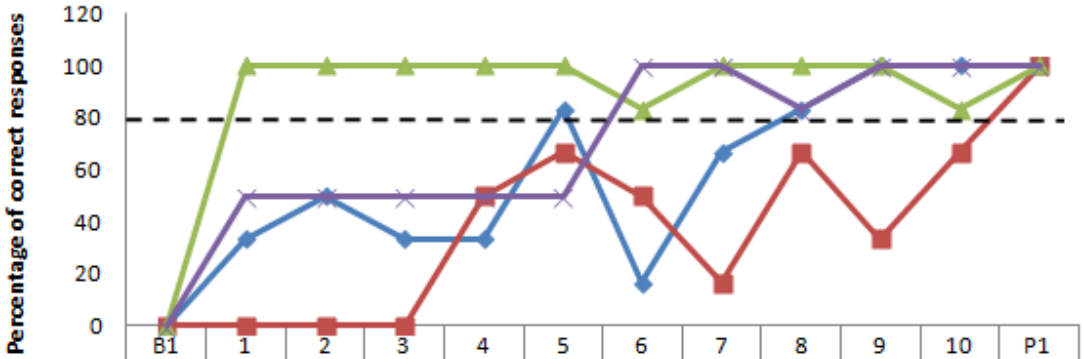
Figure 2. Percentage Correct Response of retroflex /ʈ/ production in the context of various vowels by participant 2 (S2) in word initial position



	B1	1	2	3	4	5	6	7	8	9	10	P1
/ʈa/-M	0	50	83.33	100	100	33.33	83.33	83.33	50	100	50	100
/ʈi/-M	0	66.66	16.66	50	66.66	50	66.66	66.66	16.66	66.66	83.33	0
/ʈu/-M	0	100	100	100	100	83.33	100	100	100	83.33	83.33	100
/ʈo/-M	0	50	50	100	100	100	100	100	100	100	100	100

(/ʈa/-M: /ʈ/ in the context of vowel /a/ in medial position; /ʈi/-M: /ʈ/ in the context of vowel /i/ in medial position; /ʈu/-M: /ʈ/ in the context of vowel /u/ in medial position; /ʈo/-M: /ʈ/ in the context of vowel /o/ in medial position. B1- Pretherapy baseline; P1- Post therapy baseline)

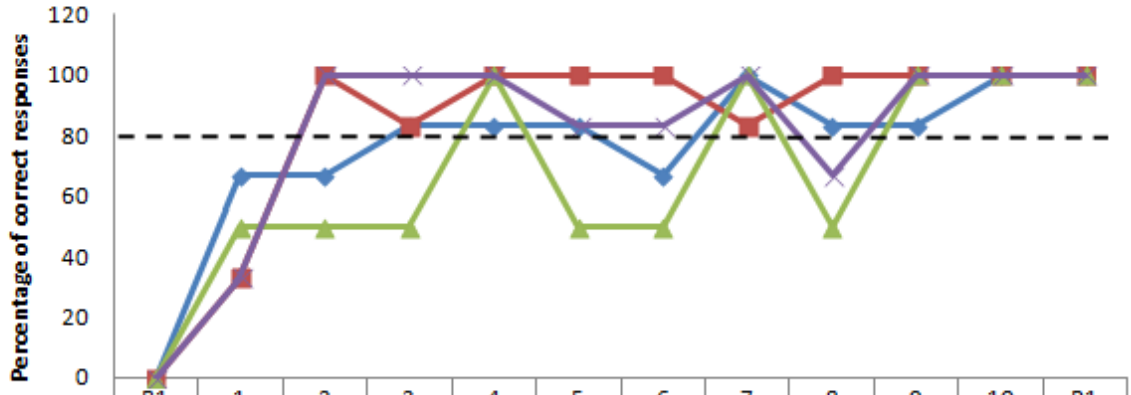
Figure 5. Percentage Correct Response of retroflex /ʈ/ production in the context of various vowels by participant 2 (S2) in word medial position



	B1	1	2	3	4	5	6	7	8	9	10	P1
/ʈa/-M	0	33.333	50	33.333	33.333	83.333	16.667	66.667	83.333	100	100	100
/ʈi/-M	0	0	0	0	50	66.667	50	16.667	66.667	33.333	66.667	100
/ʈu/-M	0	100	100	100	100	100	83.333	100	100	100	83.333	100
/ʈo/-M	0	50	50	50	50	50	100	100	83.333	100	100	100

(/ʈa/-M: /ʈ/ in the context of vowel /a/ in medial position; /ʈi/-M: /ʈ/ in the context of vowel /i/ in medial position; /ʈu/-M: /ʈ/ in the context of vowel /u/ in medial position; /ʈo/-M: /ʈ/ in the context of vowel /o/ in medial position. B1- Pretherapy baseline; P1- Post therapy baseline)

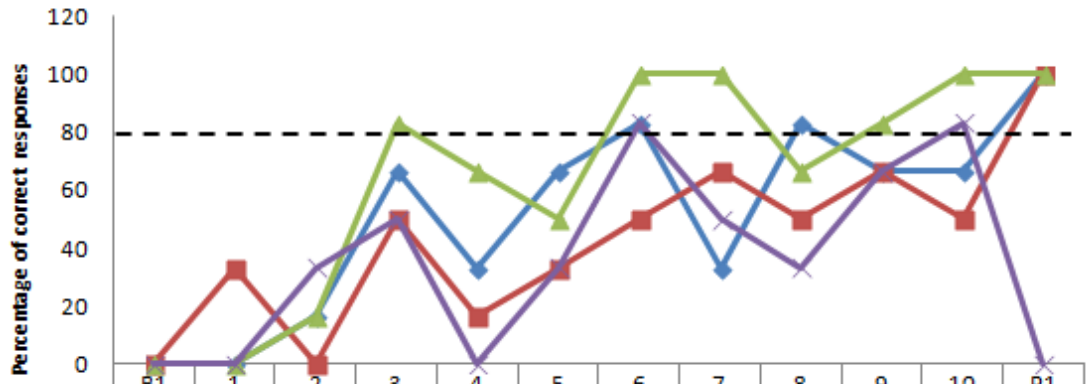
Figure 6. Percentage Correct Response of retroflex /ʈ/ production in the context of various vowels participant 3 (S3) in word medial position



	B1	1	2	3	4	5	6	7	8	9	10	P1
/ɖa/-I	0	66.66	66.66	83.33	83.33	83.33	66.66	100	83.33	83.33	100	100
/ɖi/-I	0	33.33	100	83.33	100	100	100	83.33	100	100	100	100
/ɖu/-I	0	50	50	50	100	50	50	100	50	100	100	100
/ɖo/-I	0	33.33	100	100	100	83.33	83.33	100	66.66	100	100	100

(/ɖa/-I:/ɖ/ in the context of vowel /a/ in initial position; /ɖi/-I: /ɖ/ in the context of vowel /i/ in initial position; /ɖu/-I: /ɖ/ in the context of vowel /u/ in initial position; /ɖo/-I: /ɖ/ in the context of vowel /o/ in initial position. B1- Pretherapy baseline; P1- Post therapy baseline)

Figure 8. Percentage Correct Response of retroflex /ɖ/ production in the context of various vowels by participant 3 (S3) in word initial position



	B1	1	2	3	4	5	6	7	8	9	10	P1
/ɖa/-M	0	0	16.66	66.66	33.33	66.66	83.33	33.33	83.33	66.66	66.66	100
/ɖi/-M	0	33.33	0	50	16.66	33.33	50	66.66	50	66.66	50	100
/ɖu/-M	0	0	16.66	83.33	66.66	50	100	100	66.66	83.33	100	100
/ɖe/-M	0	0	33.33	50	0	33.33	83.33	50	33.33	66.66	83.33	0

(/ɖa/-M: /ɖ/ in the context of vowel /a/ in medial position; /ɖi/-M: /ɖ/ in the context of vowel /i/ in medial position; /ɖu/-M: /ɖ/ in the context of vowel /u/ in medial position; /ɖe/-M: /ɖ/ in the context of vowel /e/ in medial position. B1- Pretherapy baseline; P1- Post therapy baseline)

Figure 10. Percentage Correct Response of retroflex /ɖ/ production in the context of various vowels by participant 3 (S3) in word medial position

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Children's acquisition of inchoative constructions in Korean

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Abstract

This study aims to explore the development of the Korean inchoative morpheme *-eci* on inherently stative predicates and inherently inchoative predicates. In particular, this study experimentally investigates whether or not Korean children know two ways of forming inchoatives: morphological inchoatives derived by application of the morpheme *-eci* (i.e. stative predicate+*-eci*) vs. lexical inchoatives which cannot be marked by *-eci* due to the morphological blocking effect (i.e. inchoative predicate+-∅). To address this question, a forced-choice preference task was conducted with thirty Korean monolingual children aged from four to six. Our results across age groups revealed a continuous development pattern for morphologically-derived inchoatives and interestingly, a U-shaped development pattern for lexical inchoatives.

Keywords *eci*-inchoatives, inchoative states, morphological blocking, U-shaped curve, Korean

1. Introduction

1.1. Two kinds of inchoatives in Korean and morphological blocking

Korean has two ways of marking inchoativity in predicates: morphological inchoatives and lexical inchoatives. The morphological inchoative can be derived by application of the morpheme *-eci*[2] adding an inchoative meaning, i.e. a BECOME component, to a predicate stem (cf. Lee, 1973; Chung, 2005; Joo, 2008; Lim, 2010 among others) and as such, the derived inchoative verb is roughly translated as 'become/get to be state'. To illustrate, consider the following examples.

(1) a. Sue-ka pikonha-ess-ta. → [tired(Sue)]
Sue-NOM tired-PFCT-DEC[3]
'Sue was tired.'

b. Sue-ka pikonha-**eci**-ess-ta. → [BECOME [tired(Sue)]]
Sue-NOM tired-INCHO-PFCT-DEC
'Sue got tired.'

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[2] Note that in Korean, there is another inchoative morpheme *-i* which appears variously as *-i, -hi, -li, -ki* (Lee, 1986; Lee, 1987; Park, 1994; Yeon, 2003; Kim, 2005; Kim, 2009). The present study focuses only on the case of *-eci*.

[3] Abbreviations used throughout this paper are: ACC = accusative case, CAUS = causative marker, DEC = declarative, INCHO = inchoative morpheme, INFIN = infinitive form, NEG = negation, NOM = nominative case, PASS = passive marker, PFCT = perfect aspect, PRES = present marker, TOPIC = topic marker

The sentence (1a) includes the predicate *pikonhata* describing a property of Sue's being tired, which does not involve an intrinsic transition into the described property. In (1b), the inchoative morpheme *-eci* can take this stative predicate as its argument without inducing ungrammaticality of the resulting sentence. Consequently, the combination of the stative predicate with the inchoative morphology *-eci* yields an inchoative interpretation where the change from 'not being tired' to 'being tired' takes place and the described (resultant) property of Sue's being tired starts to hold at utterance time.

On the other hand, Korean has lexical inchoatives which are specified in the lexicon (cf. Chung, 2005; Kim, 2009; Choi, 2015a, b, c; Jeong, 2017) and thus cannot felicitously combine with the inchoative morpheme *-eci*, as shown in (2).

(2) a. Sue-ka cichi-ess-ta. → [BECOME [tired(Sue)]]
Sue-NOM tired-PFCT-DEC
'Sue got tired.'

b. Sue-ka cichi-***eci**-ess-ta. → [***BECOME** [BECOME [tired(Sue)]]
Sue-NOM tired-INCHO-PFCT-DEC
*'Sue got got tired.'

The bare form of the predicate *cichita* in (2a) gives rise to an inchoative interpretation, i.e. *Sue comes to be tired*, on a par with that of the inchoative verb derived by *-eci* in (1b). This is because the predicate *cichita* 'become tired' is inherently inchoative which is lexically specified to make reference to the change into the described property. Predicates of this group are referred to as "inchoative states"[4] (Chung, 2005; Lee, 2006; Choi, 2015a, b, c) in Korean which refer not only to a property (just like typical stative predicates), but crucially also to its onset (i.e. the beginning), that is the prior change bringing the state about (unlike typical stative predicates). Hence, these predicates can yield, in the absence of an inchoative morpheme *-eci* corresponding to 'become', an inchoative interpretation ((as in (2a)). Given that an inchoative interpretation is available with the lexical information of the predicate *cichita* 'become tired', the combination with the morphology *-eci* itself adding an inchoative meaning ((as in (2b)) is illicit. We consider the incompatibility of the inchoative morpheme *-eci* with the inchoative state predicate in (2b) as a morphological blocking effect, the general idea being that one way of expressing a given meaning may block another way of expressing it.

As discussed in many previous studies, morphological blocking effects are cases where one specific form blocks the use of another expected form in a paradigm structure (Aronoff, 1976; Miyagawa, 1984; Andrews, 1990; Poser, 1992; Kiparsky, 2005; Embick, 2007, 2008; Kotek & Erlewine, 2013 and

[4] Note that Korean is not the only language that has so-called inchoative state predicates. A survey of the recent literature shows that inchoative states have been argued to be tested cross-linguistically. They have been reported in languages such as Skwxwú7mesh (Bar-el, 2005), Japanese (Kiyota, 2008), Niuean, St'át'imcets (Davis, 2012; Matthewson, 2013, 2014), Spanish (Marín & McNally, 2005, 2011 for reflexive psychological verbs).

many others). The most well-known example is the past tense paradigm in English. In this paradigm, there are two distinct forms: (i) a regular form (e.g. *walked, cooked*) morphologically derived by application of the past tense suffix *-ed* to verb stems; (ii) an irregular form (e.g. *gave, went, cut*) which are lexically specified for the past tense. For the past tense of the verb *give*, the "irregular" form *gave* blocks the otherwise expected "regular" form **gived* which is derived by application of the morphological rule *-ed* to the verb. Another example proposed by Aronoff (1976) is that the occurrence of the lexically-specified form *glory* blocks the rule-derived form **gloriosity*, derived by application of the affix *-ity*, that is responsible for forming words such as *curiosity* from occurring. Many previous studies in the literature have assumed that blocking effects take place as the result of competition between simple and more complex words (Aronoff, 1976 among many others). That is, the simple form (i.e. lexically-specified ones) wins over the more complex one (i.e. rule-derived ones) in the competition and thus, blocking effect occurs in this case.

Turning to the sentence (2), we assume that blocking is found with lexical inchoatives in Korean. Inchoative state predicates such as *cichita* 'become tired' are lexically generated to express an inchoative meaning. The bare form of the inchoative state predicate *cichita* 'become tired' in (2a) will thus block the derivation of the semantically identical form **cichi-eci-ta* putatively derived by application of the overt inchoative morpheme *-eci* ((as in (2b)). Hence, once Korean speakers have the word *cichita* 'become tired' stored as an inchoative state predicate in their lexicon, they do not apply the morphological rule *-eci* to the predicate *cichita* 'become tired' to generate a new inchoative verb. However, such morphological blocking effects do not occur in the case of inherently stative predicates (cf. (1b)) since they do not have an inherent inchoative meaning.

To summarize, when a given predicate is lexically specified to express a stative meaning, the rule-derived form (predicate stem+*-eci*) is generated to express an inchoative meaning. Conversely, when a given predicate is lexically specified to express an inchoative meaning, the bare form (predicate stem+-∅) is generated to express the latter meaning, due to the morphological blocking effect. Thus, two kinds of inchoative constructions can be distinguished in Korean with respect to the distribution of the inchoative morpheme *-eci*: (i) morphological inchoatives marked by the morpheme *-eci*; (ii) lexical inchoatives marked by a zero morpheme, which cannot be marked by *-eci*.

1.2. Distinction between stative predicates and inchoative predicates

Before setting out on our experimental investigation of inchoative constructions in Korean, we briefly discuss the distinction between stative predicates (e.g. *pikonhata* 'tired') and inchoative state predicates (e.g. *cichita* 'become tired') in this section. Since at first glance, an inchoative state predicate seems to describe a property just like a typical stative predicate, one might wonder whether the (in)compatibility of the inchoative morpheme *-eci* is the only way of distinguishing inchoative state predicates from typical

stative predicates in Korean. However, these two kinds of predicates can be distinguished with respect to several diagnostics. Here, we particularly, invoke two diagnostics: (i) the present marker *-nun*/*-∅*; (ii) the addition of a punctual adverbial clause (see Choi, 2015a, c for other diagnostics).

First, inchoative state predicates and stative predicates can be morphologically distinguished with respect to the present marker *-nun*/*-∅*. It has been traditionally argued that verbal predicates in Korean take the overt present marker *-nun* (or its allomorph *-n*), while adjectival (or non-verbal) predicates cannot take it (Soh, 1995; Han, 1996; Chung, 1999 among others), as shown in (3a-b) below.

(3) a. Juno-nun sakwa-lul mek-**nun/*∅**-ta.
Juno-TOP apple-ACC eat-PRES-DEC
'Juno is eating/eats an apple.' [verbal predicate]
b. Juno-nun haksayng-i-**∅/*n**-ta.
Juno-TOP student-be-PRES-DEC
'Juno is a student.' [nominal predicate]

(4) a. Juno-nun pikonha-**∅/*n**-ta.
Juno-TOP tired-PRES-DEC
'Juno is tired.' [stative predicate]
b. Juno-nun cichi-**n/*∅**-ta.
Juno-TOP get.tired-PRES-DEC
'Juno is getting/gets tired.' [inchoative state]

As can be seen in (4a-b) above, the stative predicate *pikonhata* 'tired' cannot take the overt present marker *-nun*, while the inchoative state predicate *cichita* 'get tired' can felicitously combine with *-nun* like other verbal predicates. The contrast shown in (4a-b) suggests that inchoative states should be distinguished from typical stative predicates since the latter are adjectival predicates, whereas inchoative states are verbal predicates.

Second, inchoative state predicates and stative predicates do not pattern together with respect to the addition of a punctual adverbial clause which can induce three different readings according to the aspectual properties of predicates: (i) an inceptive (inchoative) reading where the described eventuality in the main clause begins at the same time as the event described by the punctual clause; (ii) a medial (overlapping) reading where the described eventuality takes place simultaneously with the event described by the punctual clause; (iii) a culminating reading where the described eventuality ends simultaneously with the event described by the punctual clause (cf. Bar-el, 2005). Crucially, Bar-el argues that if the inceptive reading is the only available reading, then the matrix predicate contains the onset of the described eventuality (i.e. an initial boundary) in its lexical meaning. Consider now the following examples.

(5) *Inchoative state predicate*
Juno-nun [ku sosik-ul tul-ess-ul ttay] hwana-ss-ta.
Juno-TOP that news-ACC hear-PFCT-when get.angry-PFCT-DEC
'Juno got angry when he heard that news.'

a. ✓Juno was not angry before, but he became angry because of that news.
b. ×Juno was already angry when he heard that news.

(6) *Stative predicate*
Juno-nun [nay-ka cenhwahay-ss-ul ttay] aph-ass-ta.
Juno-TOP I-NOM call-PFCT-when sick-PFCT-DEC
'Juno was sick when I called him.'
a. ×Juno was not sick before, but he got sick when I called him.
b. ✓Juno was already sick when I called him.

The sentence (5) containing the inchoative state predicate *hwanata* 'get angry' in the main clause can be accepted only under an inceptive context (5a). On the contrary, the sentence (6) containing the typical stative predicate *aphuta* 'sick' can be accepted only under a medial (overlapping) context (6b). The examples (5-6) show that stative predicates and inchoative state predicates do not have the same aspectual properties.
As we have observed so far, inchoative state predicates and typical stative predicates pattern differently with respect to morphological and aspectual diagnostics including the distribution of the inchoative morpheme *-eci* and as such, they can be clearly distinguished from each other. Importantly, based on the results of these diagnostics, predicates used in our experimental study were classified as either stative or inchoative.

1.3. Acquisition of the inchoative construction in child Korean

Turning to the target property of our experimental study, we might wonder now whether or not Korean children know two ways of forming inchoatives: inchoatives marked by the morpheme *-eci* (i.e. derived inchoatives) vs. inchoatives marked by a zero morpheme which cannot be marked by *-eci* (i.e. lexical inchoatives).
Despite the numerous theoretical studies on the inchoative construction in Korean proposed in the literature (Lee, 1973; Ko, 2001; Yeon, 2003; Park, 2005; Zubizarreta & Oh, 2007; Kim, 2009; Lim, 2010; Kim & Lee, 2013 among others), few studies experimentally have dealt with the acquisition of this aspect. Moreover, previous studies have mainly focused on second language (L2) acquisition of the causative/passive-inchoative alternations in Korean in terms of agentivity (Kim, 2004; Joo, 2008). Crucially, however, previous experimental studies did not directly investigate the contrast between two kinds of inchoatives with respect to the morphology *-eci*, i.e. *eci*-inchoatives (i.e. derived inchoatives) vs. lexical inchoatives (without *-eci*), in Korean. Thus, to the best of our knowledge, the present study is the first experimental study investigating children's acquisition of this aspect. To address this question, an experiment was carried out with Korean children aged from four to six, which will be reported in the following section.

1.4. Purpose of this study and research questions

The purpose of this study is to explore the development of the Korean inchoative morpheme *-eci* on inherently stative predicates and inherently

inchoative state predicates. The research questions can be specified as follows.

(i) How do Korean children acquire the inchoative morpheme *-eci* on inherently stative predicates?
(ii) Can they apply a process of morphological blocking for the case of inherently inchoative predicates?
(iii) Do they acquire simultaneously the morphological rule of *-eci* and the morphological blocking principle?

2. Methodology

In this study, a forced-choice preference task (Montrul, 1998; Geeslin & Guijarro-Fuentes, 2006; Cuza & Franck, 2011; Stringer, Burghardt, Seo & Wang, 2011 among others) was conducted. The goal of this task was to investigate the preference that Korean children and control adults had regarding the way of expressing an inchoative context with a given verb. The main reason why a preference task was adopted is that a production task is difficult to carry out with young children. In a pilot study, we used an elicited production task, designed to induce a production of the inchoative morpheme *-eci*. Most participants, however, did not volunteer the target lexical item as shown in (7).

(7) a. *Target sentence:*
Kom-i **ttwungttwungha-eci**-ess-eyo.
bear-NOM fat-INCHO-PFCT-DEC
'A/the bear became fat.'

b. *Volunteered sentences:*
Kom-i ice-nun **an** **nalssinha**-eyo.
bear-NOM now-TOP NEG thin-DEC
'A/the bear is not thin now.'
Kom-i **ttwungttwungha-ta**-yo.
bear-NOM fat-INFIN-DEC
'A/the bear fat (infinitive form).'

Accordingly, the criterion of scoring a response as 'correct' or 'incorrect' was very ambiguous. This is why we changed experimental method in this study, in order to get results that would be more straightforward than those of a production task.

2.1. Participants

Thirty Korean monolingual children participated in this study: ten four-year-olds (aged from 4;0 to 4;9, M_{age} = 4;5), ten five-year-olds (aged from 5;0 to 5;9, M_{age}= 5;4), and ten six-year-olds (aged from 6;0 to 6;8, M_{age}= 6;3). Twenty Korean adults (M_{age}= 30) were also included in this study as a control group. All children and adults who participated in this study were native speakers of Korean.

2.2. Procedure and materials

The experimental conditions were constructed with predicate type (*inherently stative predicates vs. inherently inchoative state predicates*) and inchoative form (*bare form vs. rule-derived form*) as factors. Participants were presented a change-of-state context where an individual or an object undergoes a transition from one state (*not having the target property*) to another state (*having the target property*) as the experimental context. The experimental conditions are summarized in Table 1.

Table 1
Experimental conditions

Condition 1:	Stative predicates	bare form (predicate+∅) rule-derived form (predicate+-*eci*)
Condition 2:	Inchoative state predicates	bare form (predicate+∅) rule-derived form (predicate+-*eci*)

Children were tested individually in a separate room by an experimenter. They were presented with visual materials depicting a change-of-state in the form of animated PowerPoint slides, and a target sentence without a predicate. A lead-in question 'What has changed?' was given to two puppets, to make sure that children understand the change-of-state context. Then, the puppets were asked to complete the given sentence according to what they observed in the context: one puppet uttered a test sentence with the inchoative morpheme *-eci* and the other uttered it without *-eci*. After the two variants of target sentence had been uttered, the children were asked to choose which of the two puppets described well the given context. There was not third or fourth options made available to the children, i.e. accepting both or none. This was done to make sure that the children made a straightforward decision as to which option they preferred according to the context.

Each participant received twelve test items interspersed with twelve fillers[5] for a total of twenty-four items. As shown in Table 2, each of the six inherently stative predicates is paired with the six inherently inchoative state predicates sharing same semantic fields. Recall that several diagnostics including the distribution of the inchoative morpheme *-eci* were used as criteria to classify test predicates as stative or inchoative.

[5] The twelve fillers were composed of sentences testing children's knowledge of tense markers and verb meanings, thereby preventing children from detecting an experimental pattern. Filler items were also used to control whether children paid attention to the task.

Table 2
Experimental items

Stative predicates	Inchoative state predicates
celmta 'young'	*nulkta* 'get old'
pisushata 'similar'	*talmta* 'get alike'
nalssinhata 'thin'	*maluta* 'get thin'
ttwungttwunghata 'fat'	*salccita* 'get fat'
hayngpokhata 'happy'	*hwanata* 'get angry'
chwukchwukhata 'moist'	*cecta* 'get moist'

Test items and filler items were presented in a random order, which was kept constant across participants. The number of target patterns given by each puppet was counterbalanced across items and the order in which the puppets spoke was also counterbalanced. This was important in so far as it allows to prevent any general preferences that children may show for one puppet. Figure 1 below gives an example of the test items translated into English. The full list of the original items used in the experiment is given in Appendix.

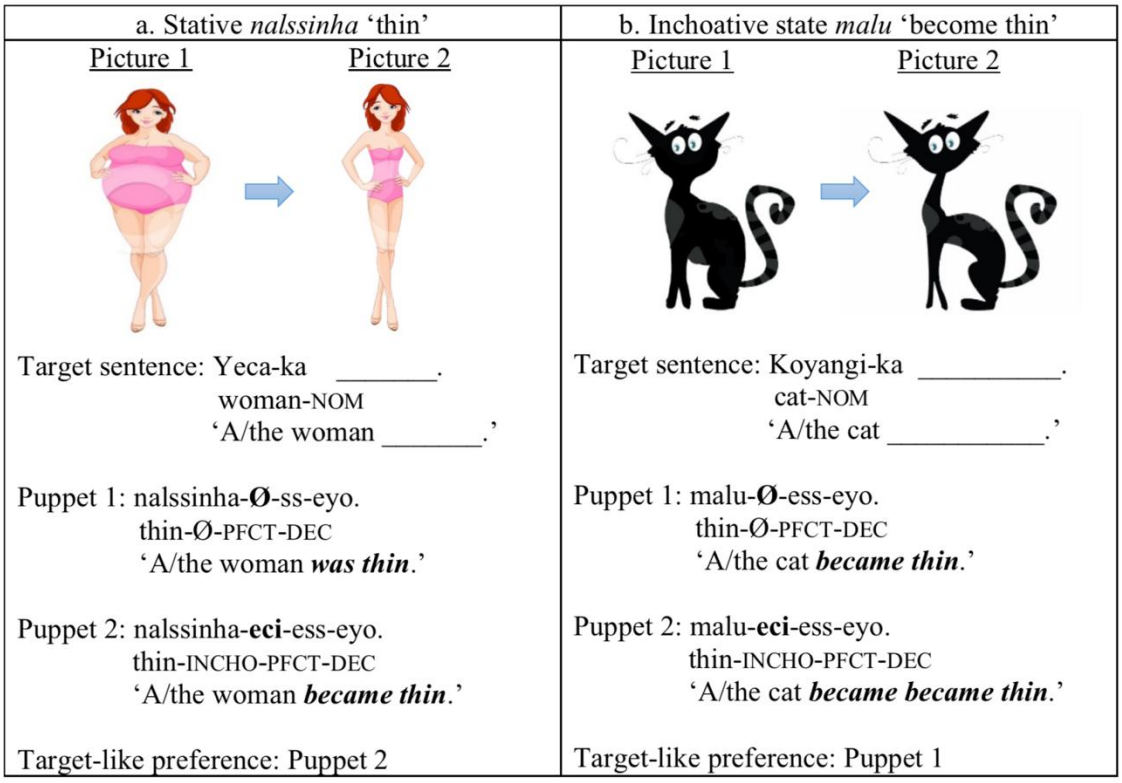

Figure 1. Semantic pair of the stative predicate nalssinhata 'thin' vs. the inchoative state predicate maluta 'become thin'

As can be seen in Figure 1, both the stative predicate *nalssinhata* 'thin' and the inchoative state predicate *maluta* 'become thin' are proposed in a change-of-state context where the subject undergoes a change from *not being thin* to *being thin*. To describe the given context, the puppet 1 proposes the bare form of the predicate (without *-eci*) and the puppet 2 proposes the rule-

derived form of the predicate (with *-eci*). What we want to find out is whether or not children prefer the rule-derived form for the stative predicate *nalssinhata* 'thin' (i.e. *nalssinha-eci-ta*), and the bare form for the inchoative state predicate *maluta* 'become thin' (i.e. *malu-∅-ta*), applying the morphological blocking principle.
The experiment took twenty minutes, but the children were reminded that they could go back to their classroom whenever they wanted to. The responses were written on an answer sheet.

3. Findings

3.1. Results by age groups

The dependent variable in the following analyses was the percentage of correct responses for each predicate type[6] [7]. No participant was excluded from the analyses and there was no child who constantly chose the same puppet. Figure 2 below presents the results by age groups.

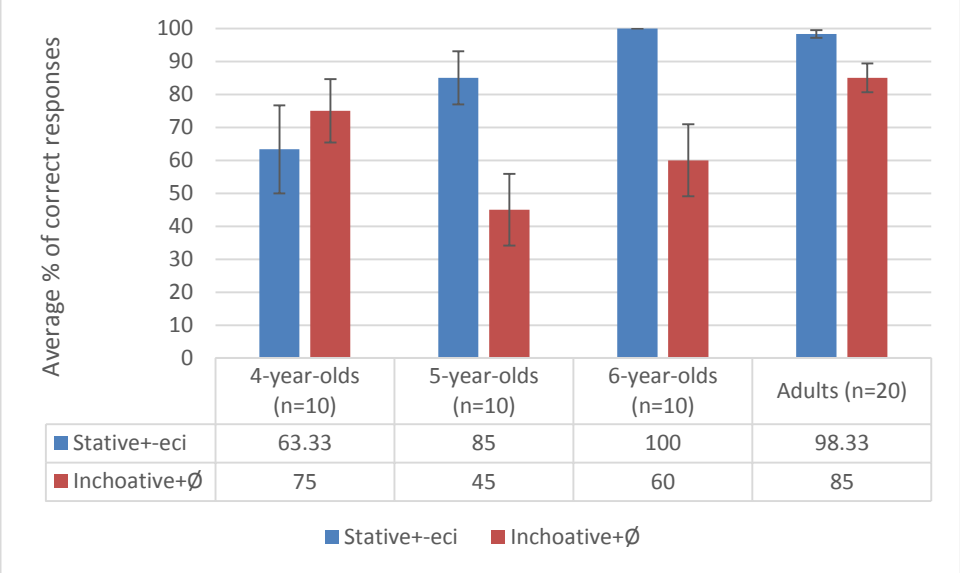

Figure 2. Results by age groups: Average preference (%) for the target inchoative form

Let us consider the results for the adult control group. Adults showed the expected target preference on both the stative predicate and the inchoative state predicate conditions. They showed a very strong tendency to prefer the rule-derived form, i.e. stative predicate+*-eci*, (98.33% of preference) over the bare form. On the inchoative state predicate condition, they showed relatively higher levels of preference for the bare form, i.e. inchoative state predicate+∅ (85% of preference) over the rule-derived form, as expected[8].

[6] The incorrect responses are the exact counterpart of the correct ones.
[7] For ease of comparison, the number of correct responses for each experimental condition was transformed was transformed into percentages.
[8] One might wonder why adults did not perform at ceiling on this condition, allowing 15% of inchoative state predicates combined with the morphology *-eci*, which was not expected. Looking at the results by individual subjects, we found that these graded target-like

Given the results of the adult control group, let us now look at the results for children. First, four-year-olds, on the stative predicate condition, showed slightly higher levels of preference for the rule-derived form, i.e. stative predicate+-*eci* (63.33%) over the bare form. On the inchoative state predicate condition, they preferred the bare form, i.e. inchoative state predicate+∅ (75%) over the rule-derived form.

As for five-year-olds, on the stative predicate condition, they performed better than four-year-olds in that they mostly preferred the rule-derived form (85%) over the bare form, as expected. However, on the inchoative state predicate condition, they showed a surprising pattern: they accepted both the bare form (45%) and the rule-derived form (55%) for inherently inchoative predicate. The statistical analysis revealed that five-year-olds did not make a significant difference between the two types of the inchoative form ($\chi^2(1)=0.42$, $p = .517$), suggesting that the choice they made was done by chance between the bare form and the rule-derived form for inchoative state predicates. This pattern is very surprising since they performed worse than four-year-olds on the inchoative state predicate condition.

Six-year-olds, on the stative predicate condition, perfectly preferred the rule-derived form (100%), just like adults (98.33%). On the inchoative state predicate condition, they showed slightly higher levels of preference for the bare form (60%) than the rule-derived form. Their performance on this condition is better than that of five-year-olds (45% of preference for the bare form), but it is still worse than that of four-year-olds (75% of preference for the bare form). Six-year-olds, like five-year-olds, showed no significant difference between the bare form and the rule-derived form for inherently inchoative predicates ($\chi^2(1)=2.02$, $p = .155$).

A two-way mixed ANOVA analysis revealed that there was a significant interaction effect between age and predicate type on the target-like performance ($F(3,46) = 3.448$, $p = .024$). A one-way ANOVA was used to

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behaviors were across items. Specifically, among the adult participants, only a few participants unexpectedly chose the rule-derived form for some inchoative state predicates such as *nulkta* 'get old', *talmta* 'become alike' and *maluta* 'get thin'. One possible explanation is to suppose that those speakers considered *-eci* as a passive morpheme. Note that the picture of Korean inchoatives is complex because of overlapping uses of the morpheme (O'Grady, 1991; Sohn, 1999): the morpheme *-eci* can be used not only as an inchoative morpheme but also as a passive morpheme, as shown in (ia-c). (ib) and (ic) can be differentiated with respect to the presence of the *by*-phrase describing an agent (i.e. *by John*).

(i) a. John-i khep-ul kkay-ss-ta.
John-NOM cup-ACC break-PFCT-DEC
'John broke the cup.' [causative]

b. Khep-i kkay-**eci**-ess-ta.
cup-NOM break-ECI-PFCT-DEC
'The cup broke.' [inchoative]

c. Khep-i John-eyuyhay kkay-**eci**-ess-ta.
cup-NOM John-by break-ECI-PFCT-DEC
'The cup was broken by John.' [passive]

Another possible explanation is that some inchoative state predicates may not have been encoded as such for some adults who unexpectedly chose the rule-derived form for some inchoative state predicates. I will leave the question of why some (but not all) of the adult participants showed such variability for some (but not all) inchoative state predicates for future research.

investigate between-groups differences. There were statistically significant differences between age groups for stative predicates ($F(3, 46) = 6.668$, $p = .001$), as well as for inchoative state predicates ($F(3, 46) : 5.143$, $p = .004$). Specifically, Tuckey post hoc analyses revealed a significant difference in target-like preference on the rule-derived form of stative predicates between 4-year-olds and 6-year-olds ($p = .003$) and between 4-year-olds and adults ($p = .001$). No other comparisons were significant. On the other hand, there was a significant difference in target-like preference on the bare form of inchoative state predicates between 5-year-olds and adults ($p = .003$), while no other comparisons were statistically significant.

To summarize the results, Korean children were generally accurate in choosing the rule-derived form of inherently stative predicates to express an inchoative meaning. Specifically, the target-like preference of children on this condition improves with age. In contrast, children have some difficulties with inherently inchoative predicates. In particular, the non-target-like pattern of behavior holds for five-year-olds and six-year-olds who did not clearly prefer the bare form over the rule-derived form of inherently inchoative predicates, but much less so for four-year-olds who performed much better than older children. The questions that arise now are: why did five-year-olds and six-year-olds incorrectly choose the rule-derived form for inherently inchoative predicates? Why do these children seem to regress in expressing an inchoative meaning with inchoative state predicates, as compared to four-year-olds?

3.2. Children's error patterns

In order to answer these questions, we attempted to determine the children's patterns of behavior, considering the results broken down by minimal pairs of predicates. Recall that each of the six inherently stative predicates used in the test materials are paired with six inherently inchoative predicates sharing same semantic field (e.g. *nalssinhata* 'thin' vs. *maluta* 'get thin') (cf. Table 2). We now examine what kind of errors children committed across these minimal pairs of predicates. Breaking down the results by minimal pairs of predicates yielded three patterns of behavior provided in Table 3 and as a result, children were divided into three groups: one target-like group and two non-target-like-groups.

Table 3
Children's patterns of behavior[9]

Target-like pattern:	stative+-*eci* / inchoative+∅
Error pattern 1:	stative+-*eci* / inchoative+-*eci*
Error pattern 2:	stative+∅ / inchoative+∅

Figure 4 below illustrates the distribution of children's patterns of behavior across age groups.

[9] Note that there was no child who showed an error pattern such as 'stative+∅/inchoative+-*eci*'.

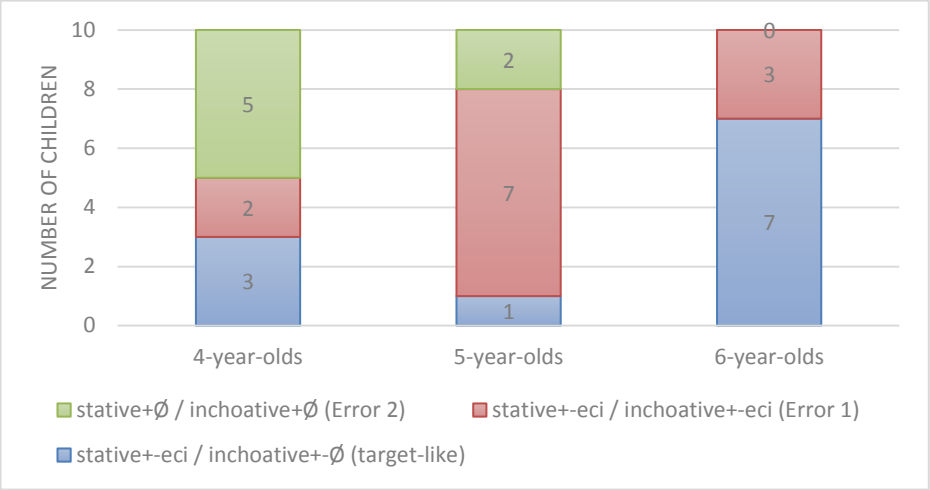

Figure 4. Distribution of children's patterns across age groups

3.2.1. Target-like pattern: stative+-eci / inchoative+∅

The first group includes children who showed the expected target pattern with respect to both stative predicates and inchoative state predicates in minimal pairs. That is, they correctly preferred both the rule-derived form for stative predicates and the bare form for inchoative state predicates (for at least four out of six test items respectively). These children are fully target-like because they crucially know that: (i) inherently stative predicates obligatorily combine with the morphology *-eci* to express an inchoative meaning; (ii) inherently inchoative state predicates do not combine with *-eci* due to the morphological blocking effect. The majority of six-year-olds (seven out of ten) were target-like in preferring the relevant inchoative form for the two types of predicates, while only some four-year-olds (three out of ten) and only one five-year-old child (out of ten) were target-like.

3.2.2. Error pattern 1: stative+-eci / inchoative+-eci

The second group includes children tending to add the overt inchoative morpheme *-eci* to both items of the relevant minimal pair. That is, these children systematically chose the rule-derived form irrespective of whether the given predicate is an inherently stative predicate or an inherently inchoative state predicate (for at least four out of six test items respectively). They correctly know that inherently stative predicates obligatorily combine with the morphology *-eci* to express an inchoative meaning. However, they committed errors with inherently inchoative predicates in overusing *-eci*. Interestingly, most five-year-olds (seven out of ten) are included in this group, while only few four-year-olds (two out of ten) and some six-year-olds (three out of ten) displayed this pattern.

3.2.3. Error pattern 2: stative+∅ / inchoative+∅

The third group includes children tending to prefer the bare form to both items of the relevant minimal pair to express an inchoative meaning (for at least four out of six test items respectively). As opposed to children in the second group, children in this group were accurate in preferring the bare form for inherently inchoative state predicates, while they committed errors

with inherently stative predicates in omitting the inchoative morphology *-eci*. Half of four-year-olds (five out of ten) and few five-year-olds (two out of ten) displayed this pattern, while no six-year-olds showed this behavior. This pattern thus decreases with age.

3.3. By-item breakdown results

Let us now consider the by-item breakdown results by age groups to understand whether there is a variability across the target items and age groups in children's target-like behaviors. Figure 5 below illustrates the target-like distribution of answers for the rule-derived form with inherently stative predicates (i.e. stative+-*eci*) by individual predicates across age groups.

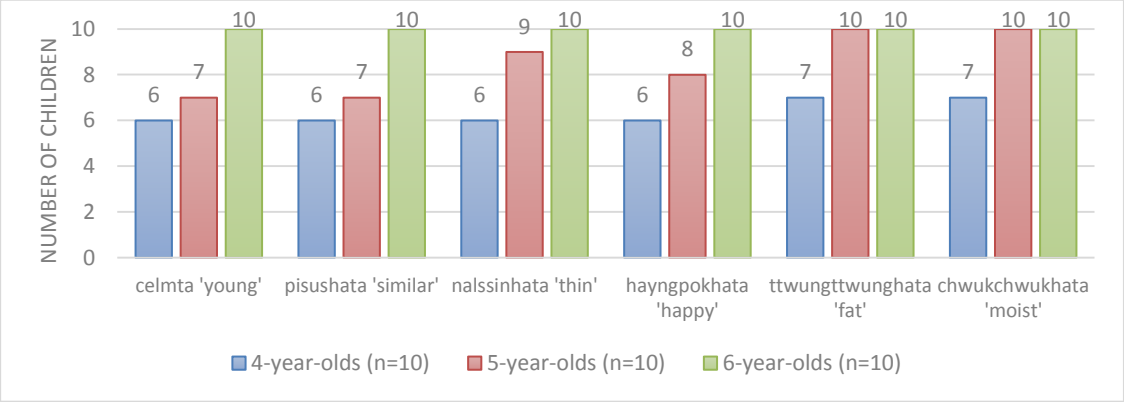

Figure 5. Results for "stative+-eci" by individual predicates across age groups

On the inherently stative predicate condition, most of the children across different age groups correctly preferred the rule-derived form with test items. In particular, there were three stative predicates, i.e. *nalssinhata* 'thin', *ttwungttwunghata* 'fat', *chwukchwukhata* 'moist', with which five-year-olds and six-year-olds accurately showed a strong preference for the rule-derived form. On the other hand, four stative predicates, i.e. *celmta* 'young', *pisushata* 'similar', *nalssinhata* 'thin', *hayngpokhata* 'happy', seem to be problematic for some four-year-olds since only about half of them (six out of ten) correctly preferred the rule-derived form with these predicates. It is also important to note that all six-year-olds correctly showed a strong preference for the rule-derived form with all stative predicate items. We thus observe a typical development pattern with inherently stative predicates.

However, with inherently inchoative state predicates, we observed a higher variability. Consider Figure 6 below that illustrates the target-like distribution of answers for the bare form with inchoative state predicates by individual predicates across age groups.

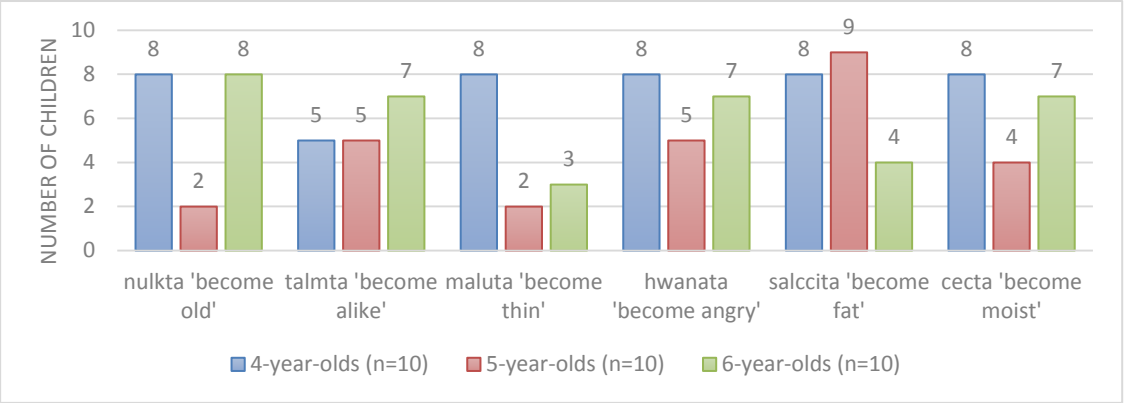

Figure 6. Results for "inchoative+∅" by individual predicates across age groups

On the inherently inchoative state predicate condition, four-year-olds generally showed the adult-like preference for the bare form, while five-year-olds and six-year-olds showed, however, some surprising results. There were three inchoative state predicate items, i.e. *nulkta* 'get old', *hwanata* 'get angry', *cecta* 'get moist', for which most four-year-olds and most six-year-olds were target-like in choosing the bare form, whereas more than half of five-year-olds were non-target-like in choosing the rule-derived form. Interestingly, younger children (four- and five-year-olds) were divided into two groups with respect to the inchoative state predicate *talmta* 'become alike': half of the four-year-olds and five-year-olds, respectively correctly preferred the bare form and the other half incorrectly chose the rule-derived form. In contrast, six-year-olds, overall, performed well with this item since seven out of ten correctly preferred the bare form. As for the inchoative predicate *maluta* 'become thin', most four-year-olds (eight out of ten) showed the target-like preference for the bare form, while only a few five-year-olds (two out of ten) and a few six-year-olds (three out of ten) showed such target-like preference. Finally, with respect to the inchoative state predicate *salccita* 'become fat', surprisingly, only some six-year-olds (four out of ten) were accurate in preferring the bare form, while younger children (eight out of ten four-year-olds; nine out of ten five-year-olds) strongly showed the adult-like pattern for the bare form with this item.

To summarize the results by individual predicates, some stative predicates seem to be problematic for some younger children, but children's target-like performance improved with age. And at the age of six, they perfectly converged on the adult-like behavior of using the morphology *-eci* with inherently stative predicates to express an inchoative meaning. However, children show higher variability with inherently inchoative state predicates than with stative predicates.

4. Discussion

We now discuss what the results of the experiment tell us about the children's acquisition of the two types of inchoatives with respect to the morphology *-eci* in Korean: derived inchoatives (i.e. stative predicate+*-eci*) vs. lexical inchoatives (i.e. inchoative state predicate+∅).

First, we found that Korean children aged from four to six were generally accurate in preferring the rule-derived form for inherently stative predicates to express an inchoative meaning. The target-like preference improves with age and as such we observe a typical development pattern with inherently stative predicates in Korean child language.

In contrast, the results for inherently inchoative predicates across age groups revealed a discontinuous development pattern in Korean child language (cf. Figure 2). Surprisingly, it is more than half of five-year-olds and some six-year-olds, rather than four-year-olds, who have difficulties with inherently inchoative state predicates. While most four-year-olds (75%) correctly preferred the bare form for inchoative state predicates over the rule-derived form, more than half of five-year-olds (55%) and some six-year-olds (40%) incorrectly preferred the rule-derived form (with *-eci*). These results are surprising in that five-year-olds and six-year-olds do not seem to converge on the adult-like pattern of behavior of expressing an inchoative meaning with inherently inchoative predicates, unlike four-year-olds. Assuming that older children are presumably more grammatically advanced than younger children and children's linguistic knowledge does not regress, then we have a puzzling pattern that we need to explain. This pattern raises the question: how can we account for the discontinuity observed in the results for inherently inchoative predicates across age groups?

Looking at the results for the target-like pattern with inherently inchoative predicates across age groups (cf. Figure 2), we can make sense of our finding if we assume that the acquisition of inherently inchoative state predicates exhibits a so-called 'U-shaped' pattern. U-shape development curves have been reported in many studies devoted to both first and second language acquisition (Bowerman, 1982; Bybee & Slobin, 1982; Karmiloff-Smith, 1986; Marcus et al., 1992; Pinker, 1984, 1991; Ellis, 1994; Lidz & Gagliardi, 2010 among many others). One of the most notorious cases of U-shaped development is the acquisition of English past tense morphology (Pinker, 1984). In the past tense paradigm, there are two distinct forms: (i) a regular form (e.g. *walked, played*) morphologically derived by means of an affixation rule which consists in adding the suffix *-ed* to verb stems; (ii) an irregular form (e.g. *gave, went*) formed in idiosyncratic ways. Recall our discussion given in the previous part concerning the principle of morphological blocking (Aronoff, 1976; Andrews, 1990 and many others). According to this principle, when speakers have a simple form lexically expressing a certain meaning listed in the lexicon, they will not resort to a morphological rule combining other morphemes to generate a form which would be semantically and syntactically identical to the stored form. Take the past tense of *give* in English, which is the irregular form *gave* stored in the lexicon. Lexical specification of the irregular past form blocks the otherwise expected form *gived* derived by application of the past tense suffix *-ed* to the verb stem. In first language acquisition, it has been observed that, after a stage of using frequent irregular past tense forms (e.g. *went, gave*) correctly, children go through a stage in which they acquire the morphological rule of *-ed* and produce overregularized incorrect past tense forms (e.g. *goed, gived*) alongside correct irregular forms. When the overregularization period is over,

children finally reach the adult-like stage in which they generate the correct past tense forms for both regular (e.g. *walked*) and irregular verbs (e.g. *went*). These three stages in the acquisition of English past tense morphology thus constitute a U-shaped development pattern.

Let us now turn to our results for inchoative state predicates: four-year-olds were mostly target-like in preferring the bare form for these predicates, five-year-olds chose both the bare form and the rule-derived form, while six-year-olds performed better than five-year-olds. We assume that these surprising results for inchoative state predicates describe a U-shaped development pattern similar to the one found in the acquisition of the past tense morphology in English, but we can implement the idea differently on our results, especially based on the distribution of children's patterns of behavior given in Table 3 and Figure 4. It is possible to assume that the U-shaped development pattern observed in our results reflects three stages in the acquisition of the inchoativity paradigm in Korean as follows:

In phase 1, children are not sensitive to the morphological rule of *-eci* adding an inchoative meaning to verb stems. The lack of the *-eci* rule in children's grammar leads them to be adult-like with inherently inchoative state predicates, but to commit error with inherently stative predicates. It results in a relatively high rate of generating *correct* bare forms 'inchoative predicate+∅', but also in a relatively high rate of generating *incorrect* bare forms 'stative predicate+∅'. Recall the main error type of younger children: half of four-year-olds and two out of ten five-year-olds showed error pattern 2 in that they preferred the bare form for both stative predicates and inchoative state predicates, whereas no six-year-olds showed this behavior, showing that this error pattern decreases with age. Children displaying this error pattern might not accurately acquire the inchoative morphology *-eci* yet, being in this early stage.

In phase 2, children's knowledge state changes into one which includes the rule of *-eci* for inchoative morphology. Crucially, however, they are not yet aware of the morphological blocking principle that occurs in the case of inherently inchoative state predicates since these predicates are lexically specified to yield an inchoative meaning. The acquisition of the inchoative morpheme *-eci* without being governed by the morphological blocking principle leads them to commit the overregularization errors of *-eci* with inherently inchoative predicates. However, the use of *-eci* leads them to be adult-like with inherently stative predicates. In particular, their insensitivity to the morphological blocking principle does not affect their adult-like performance with stative verbs since the morphological blocking effect does not occur in this case. This results in an increase of generating *incorrect* rule-derived forms 'inchoative predicate+*-eci*', due to overregularization of *-eci*, but also in an increase of generating *correct* rule-derived forms 'stative predicate+*-eci*'. Recall the main error type of five-year-olds: most five-year-olds (seven out of ten) showed error pattern 1 in that they correctly preferred the rule-derived form for stative predicates, but incorrectly overused the same form for inchoative state predicates. It could suggest that children displaying this error pattern are in this phase.

In phase 3, children come to have adult-like knowledge of the distribution of the inchoative morpheme *-eci* in accordance with the morphological blocking

principle. That is, they can associate each of the two distinct forms (-*eci* vs. ∅) in the inchoative paradigm with the right type of predicate (lexically stative vs. lexically inchoative) since, in this phase, the morphological blocking principle has settled together with the morphological rule of -*eci* in their grammar. Children thus come to know that the morphological blocking principle forbids the application of the inchoative morphological rule of -*eci* to inherently inchoative state predicates. They also know that stative predicates are not inherently inchoative and thus need the inchoative marker -*eci* to express an inchoative meaning. This results in an increase of generating *correct* bare forms 'inchoative state predicate+∅', and an increase of generating *correct* rule-derived forms 'stative predicate+-*eci*'. Children's overregularization errors of -*eci* with inherently inchoative predicates diminish at this stage. Recall that the majority of six-year-olds (seven out of ten) showed the target-like pattern in that they correctly preferred the bare form for inchoative state predicates and the rule-derived form for stative predicates. It could be assumed that at about the age of six, Korean children come to have the adult-like knowledge of -*eci* governed by the morphological blocking principle.

5. Limitations and suggestions for further research

Our results across ages revealed a typical development pattern for derived inchoatives (i.e. *eci*-inchoatives) and interestingly a U-shaped development pattern for lexical inchoatives. The observed asymmetric development pattern of behavior are interpreted as referring to a U-shaped development pattern in the present study. Even though, unquestionably, the small sample size of the present study does not allow us to draw conclusions, we have provided some preliminary assumptions on the development of the Korean inchoative morpheme -*eci* on inherently stative predicates and inherently inchoative state predicates, based on the results. Further research with more participants is required to verify our assumption. A longitudinal study could be appropriate to have a clear picture of how Korean children learn the two types of inchoatives with respect to the morphology -*eci*.

In addition, as discussed in the present study, apparently, both stative predicates and inchoative state predicates appear to describe certain properties of individuals/objects. For instance, there are two predicates both describing a property of being thin, *nalssinhata* 'thin' vs. *maluta* 'become thin'. Crucially, however, one predicate is a stative predicate yielding a stative meaning, while the other one is an inchoative state predicate yielding an inchoative meaning. Then, the question arises as to how Korean children learn the difference between an inchoative state predicate and a stative predicate in a minimal pair of predicates. Our hypothesis is that stative predicates are adjectives, while inchoative state predicates are verbs (cf. section 1.2; Choi, 2015c). So, the morphological distinction would allow children to distinguish the two kinds of predicates. At this stage, the question remains open and further studies are needed to investigate this issue.

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Appendix

Condition 1: stative predicate+-∅ vs. -*eci* (expected answer: stative+-*eci*)

Item 1:
Halmeni-ka celm-∅-ess-eyo vs. celm-eci-ess-eyo
old.woman-NOM young-∅-PFCT-DEC young-INCHO-PFCT-DEC
'An/the old woman *was young* vs. *became young*.'

Item 2:
Aypelley-ka namwusiph-kwa pisusha-∅-ess-eyo vs. pisusha-eci-ess-eyo
larva-NOM leaf-with similar-∅-PFCT-DEC similar-INCHO-PFCT-DEC
'A/the larva *was similar* vs. *became similar* to that of the leaves.'

Item 3:
Yeca-ka nalssinha-∅-ess-eyo vs. nalssinha-eci-ess-eyo
woman-NOM thin-∅-PFCT-DEC thin-INCHO-PFCT-DEC
'A/the woman *was thin* vs. *became thin*.'

Item 4:
Thokki-ka hayngpokha-∅-ess-eyo vs. hayngpokha-eci-ess-eyo
rabbit-NOM happy-∅-PFCT-DEC happy-INCHO-PFCT-DEC
'A/the rabbit *was happy* vs. *became happy*.'

Item 5:
Pyel-i ttwungttwungha-∅-ess-eyo vs. ttwungttwungha-eci-ess-eyo
star-NOM fat-∅-PFCT-DEC fat- NCHO-PFCT-DEC
'A/the star *was fat* vs. *became fat*.'

Item 6:
Thokki-uy thel-i chwukchwukha-∅-ess-eyo vs. chwukchwukha-eci-ess-eyo
rabbit-POSS hair-NOM wet-∅-PFCT-DEC wet-INCHO-PFCT-DEC
'The hair of a/the rabbit *was wet* vs. *became wet*.'

Condition 2: inchoative state predicate+-∅ vs. -*eci* (expected answer: inchoative+∅)

Item 1:
Yeca-wa namca-ka nulk-∅-ess-eyo vs. nulk-eci-ess-eyo
woman-and man-NOM get.old-PFCT-DEC get.old-INCHO-PFCT-DEC
'A/the woman and a/the man *became old* vs. *became became old*.'

Item 2:
Pheyngkwin-i ppololo-lul talm-∅-ass-eyo vs. talm-eci-ess-eyo
penguin-NOM Pororo-ACC get.alike-PFCT-DEC get.alike-INCHO-PFCT-DEC
'A/the penguin *became alike* vs. *became became alike* Pororo.'

Item 3:
Koyangi-ka malu-∅-ess-eyo vs. malu-eci-ess-eyo
cat-NOM get.thin-PFCT-DEC get.thin-INCHO-PFCT-DEC
'A/the cat *became thin* vs. *became became thin*.'

Item 4:
Kakameyl-i hwana-∅-ess-eyo vs. hwana-eci-ess-eyo
Gargamel-NOM get.angry-PFCT-DEC get.angry-INCHO-PFCT-DEC
'Gargamel *became angry* vs. *became became angry*.'

Item 5:
Namca-ka saljji-∅-ess-eyo vs. saljji-eci-ess-eyo
man-NOM get.fat-PFCT-DEC get.fat-INCHO-PFCT-DEC
'A/the man *became fat* vs. *became became fat*.'

Item 6:
Sinpal-i nwun-ey cec-∅-ess-eyo vs. cec-eci-ess-eyo
shoes-NOM snow-in get.wet-PFCT-DEC get.wet-XINCHO-PFCT-DEC
'The shoes *became wet* vs. *became became wet* in the snow.'