Discrimination of Vowel-Harmonic vs Vowel-Disharmonic Words by Monolingual Turkish Infants in the First Year of Life

Annette Hohenberger, Utku Kaya, and Aslı Altan

1. Introduction

Previous longitudinal research has revealed a familiarity-to-novelty shift in monolingual Turkish infants' preference to listen to vowel-harmonic vs vowel-disharmonic words: 6-month-olds prefer listening to harmonic over disharmonic words but 10-months-olds prefer listening to disharmonic over harmonic words (Altan, Kaya, & Hohenberger, 2016; Hohenberger, Altan, Kaya, Köksal Tuncer, & Avcu, 2016). This effect was strong for backness harmony but weak for rounding harmony. In order to find out whether Turkish infants in their first year of life distinguish not only stimuli from backness but also rounding harmony, we used a more sensitive measure in the present study: habituation and discrimination.

The organization of this article is as follows: the first section provides a definition of vowel harmony and summarizes previous work on vowel harmony and its acquisition. In section 2 the method of our discrimination experiment is outlined. Section 3 presents our findings which are discussed in section 4, followed by a conclusion in section 5.

1.1. Vowels and vowel harmony in Turkish

Turkish has 8 vowel phonemes with symmetrical [high]-[low], [front]-[back] and [round]-[unround] opposition (Kabak, 2011; Kabak & Weber, 2013: 56), see Table 1.

Table 1: Turkish vowel chart

	front		back	
	unround	**round**	**unround**	**round**
high	i	ü	ı	u
low	e	ö	a	o

Vowel harmony is the most widely known phonological characteristic of Turkic languages. In general terms, vowel harmony can be defined as a set of constraints on the co-occurrence of vowels, as follows: 'all vowels (...) in Turkish words agree in their specification for backness, and high vowels agree with preceding vowels in their specification of roundness' (Clements & Sezer, 1982: 214). These constraints hold both within a morpheme (internal vowel harmony) and across morpheme boundaries (external vowel harmony).

There are two types of vowel harmony in Turkish. (1) Backness harmony: back vowels *[a, ı, o, u]* are followed by back vowels; front vowels *[e, i, ö, ü]* by front vowels (2) Rounding harmony: a round vowel triggers rounding on the following vowel. However, in this case the target vowel has to be high. Low target vowels surface as non-round even if the preceding vowel is round (Kabak & Weber, 2013).

The external vowel harmony rule seems to be more compelling a rule than internal vowel harmony. The stimuli we used in our experiments (stem+suffix sequences) were examples of external vowel harmony.

1.2. Studies on the acquisition of vowel harmony in Turkish and other languages

The property of vowel harmony (VH) is a feature that infants begin to hear from the first moment they are exposed to Turkish. Vowel harmony (Clements & Sezer, 1982; Zimmer & Küntay, 2003; Kabak & Weber, 2013) and its acquisition (Ekmekçi, 1979; Aksu-Koç, 1985; Altan, 2009; van Kampen et al., 2008) has been the topic of many previous studies.

Previous studies have stated that children acquire vowel harmony, as evidenced in their productions, around the age of 2;0 (Ekmekçi, 1979; Aksu-Koç, 1985). In an experimental study Altan (2009) concluded that 2;0-6;0 year-old children do not experience any problems with roots and suffixes that undergo vowel harmony. The finding that children can correctly attach harmonic suffixes to borrowed and nonce words also demonstrated that they fully acquired the rules of vowel harmony. This study pointed out that children only make errors with words that were exceptions to the vowel harmony rule, e.g., '*saat*' (whose plural is '*saat-ler*'). The study found that the errors they make with irregular words decrease as they get older.

Van Kampen et al. (2008) suggested that 6-month-old Turkish infants growing up in Germany, in contrast to monolingual German infants, prefer listening to nonsense words such as *'letinn'* that obey back/front vowel harmony to non-harmonic words such as *'nelock'*. Mintz and Walker (2006) in a head turn preference study with 7-month-old infants acquiring English, familiarized them with a consonant-vowel string (*ditepubobidetupo*) and found out that infants prefer to listen to vowel harmonic CVCV sequences from the string such as *dite, pubo* over non-harmonic sequences such as *tepu, bobi, detu*. They concluded that 7-month-old infants were sensitive to vowel harmony patterns and they use

harmony as a cue to word segmentation, positing a word boundary at points of disharmony, pointing to a universal sensitivity. Ketrez (2013) analysed child-directed speech in a corpus study comparing harmonic (Turkish and Hungarian) and non-harmonic languages (Farsi and Polish). She claims that harmonic languages provide learners with harmony cues for word segmentation. Similar findings were also reported in other vowel harmonic languages as Finnish, where adult speakers used vowel harmony for speech segmentation (Suomi, McQueen & Cutler, 1997). Kabak, Maniwa & Kazanina (2010) found that adult Turkish speakers but not French speakers, rely on harmony cues in speech segmentation.

Our own recent work (Altan et al., 2016; Hohenberger et al., 2016) revealed that 6- and 10-month-old monolingual Turkish infants are already sensitive to backness vowel harmony in stem-suffix sequences. Using a preferential looking paradigm, listening times between 2 vowel-harmonic and 2 vowel-disharmonic lists of words for backness and rounding harmony were compared. While only main effects of age and trial were found for rounding harmony, in backness harmony a significant interaction between harmony and age was found: 6-month-olds preferred listening to harmonic words whereas 10-month-olds preferred listening to disharmonic words. This finding is reminiscent of the "familiarity-to-novelty-shift" in cognitive development, indicating that younger infants first extract the regular, harmonic pattern in their ambient language, whereas older infants' attention is drawn to irregular, disharmonic tokens, due to violation-of-expectation.

1.3. Habituation

Habituation is a tool in infancy research with a longstanding tradition (for overviews, see Aslin, 2007; Colombo & Mitchell, 2009; Oates, 2010). The success of this tool is grounded in the general scope of habituation as a model of how preverbal infants process information in various domains and how they categorize, learn and memorize that information (Sirois & Mareschal, 2004, p. 1357). Habituation refers to the robust finding of "decreased responsiveness over repeated stimulation" (Sirois & Mareschal, 2002, p. 293, cf. Colombo & Mitchell, 2009; Oates, 2010; Turk-Browne et al., 2008). Even more importantly than studying habituation in its own right (Colombo & Mitchell, 2009) researchers have used habituation as a technique to study early discrimination abilities in preverbal infants (Turk-Browne et al., 2008), in particular in combination with looking paradigms (Aslin, 2007). In the course of habituation, the infant processes the repeating stimuli with less effort and eventually "habituates" to it, i.e., loses interest in it, as evidenced in decreasing looking times. If, however, a novel stimulus is presented that differs from the old one in a critical dimension, her interest resurges and the infant attends longer to that novel stimulus – she "dishabituates". The rationale of habituation in combination with discrimination lies in the manipulation of the contrastive dimension between the old and the novel stimulus: "Looking-time preferences for novel stimuli over repeated stimuli

serve as the primary dependent measure, and indicate both that the infant can discriminate along the dimension that distinguishes the test items, and that they have memory for the repeated stimulus" (Turk-Browne et al., 2008, p. 4).

Here, we chose habituation because it is a more sensitive measure of infants' early competence as compared to other methodologies (Turk-Browne et al., 2008, p. 4). We hope to receive more conclusive answers to questions that remained open in our previous research (Altan et al., 2016; Hohenberger et al., 2016), in particular related to the two harmony types – backness and rounding.

Based on these considerations, our research questions are as follows: First, do young monolingual Turkish infants discriminate between vowel-harmonic and –disharmonic versions of stem-suffix sequences at the age of 6 and 10 months, respectively? Second, do they do so equally for [back-front] as well as [round-unround] stimuli? Third, do they do so equally when being presented with the harmonic or the disharmonic version of the stimulus in the habituation phase before the test? Besides the main effects, there might be interactions between these factors.

2. Methods
2.1. Participants

A total of n=83 infants (45 females) participated in the study, 40 at 6 months (M=185.88 days, SD=10.87), 43 at 10 months (M=309.30, SD=11.87). Among them, 23 infants were tested at both ages. Participants were recruited from a database of birth records at a state university hospital and from respondents to a call for participants placed on our lab's internet website: http://bebem.ii.metu.edu.tr/. All infants were healthy, born between 36-42 weeks of gestation and had no auditory problems. Both parents were native Turkish speakers and Turkish was the only language spoken in their homes.

2.2. General Procedure

Experiments were conducted in the Babylab facility at the Informatics Institute, Middle East Technical University (METU) in Ankara, Turkey. Families were invited to the lab during hours in which their infants would be usually alert. Parents completed a questionnaire including information about their infant's birth, health condition and language environment. Then, one of the parents and the infant moved to the experiment room. The parent was asked to wear headphones and listen to music during the experiment in order to prevent any response to the experimental stimuli. During the experiment the infant sat on their caregiver's (mostly their mother's) lap in front of a LED monitor at a comfortable distance. A dome camera mounted centrally above the monitor recorded the looking behaviour of the infant (see Figure 1). From the control room, one of the researchers conducted the presentation of the auditory stimuli while another

researcher observed and coded the infant's looking/listening behaviour on-line. Stimuli were presented with E-prime 2.0 software.

2.3. Phases in the Experiment

Our study used a cross-modal visual-auditory habituation paradigm. We combined an auditory stimulus – a vowel-harmonic or –disharmonic word – with an attractive visual stimulus displayed on the left or right of a computer screen, namely a yellow duck which jumped up and down synchronously with the sound of the stimulus words (see Figures 1+2). Infants' looks to the visual object/sound source were taken as indicator of active listening. Since Horowitz (1975) found that "duration of looking to a neutral *visual* stimulus can also serve as a spontaneous measure of auditory processing" (Aslin, 2007, p. 51), such cross-modal paradigms have flourished in research on speech and language development.

Figure 1. Experimental setting: Infant and mother in front of the monitor.

There were 2 phases in the experiment: (1) Habituation, (2) Test.

Habituation: In the habituation phase, infants were presented with one stimulus word randomly selected from the overall set of stimulus words (see section 2.4 and Table 2) for a variable number of trials. As habituation protocol, an infant-controlled procedure (ICP, see Colombo & Mitchell, 2009, p. 228) was chosen. Trial length was thus depending on the sustained interest of the infant in listening to the auditory stimuli. Infant looking/listening times were monitored on-line with a coding program called BABY[2]. The BABY program accumulates listening times until the criteria for terminating a trial are met. Criteria for

---

[2] We kindly acknowledge the use of the BABY program which was originally developed by Renée Baillargeon.

terminating a trial were set to (i) a minimum listening time of 1 s and a cut-off point after the baby was looking-away from the sound source of 0.5 s. The maximum length of a trial was 30 s. The standard criterion of habituation was used, i.e., when a 50% decrease in looking time was reached between the sum of the looking times of the first three and the last three trials (Colombo & Mitchell, 2009; Oates, 2010). This criterion could be reach with a minimum of six trials. If the criterion was not met at that point, a sliding window strategy (Oates, 2010) was used, i.e., we continued with the habituation protocol and compared the sum of any following trial triple to the initial triple up to a total of 10 trials. After that maximum number of trials all infants – be they habituated or not – were referred to the test phase. We did so in order to avoid losing participants due to fussiness.

The temporal substructure of habituation and test trials was as follows (see Figure 2): First, a yellow smiley which made a squeaky sound and rotated was presented in the centre of the screen, as an attention grabber. When the infant attended to it, the yellow duck was presented at either the left or right side of the screen. When the infant looked at the duck, the auditory stimulus word was presented while the duck was jumping up and down synchronously. The words had a length of 1 s approximately, with an inter-stimulus interval (ISI) or 1 s also. The auditory presentation lasted until the minimal looking and look-away criterion had been fulfilled or the maximum trial length had been reached.
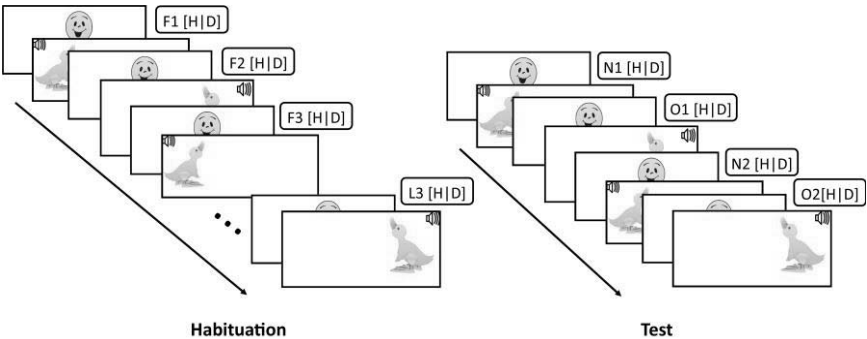

Figure 2. Habituation and test trial sequence

Test: After habituation was reached or ten habituation trials had elapsed, infants were presented with four alternating new and old test trials. That is, if the habituated word had been a vowel-harmonic one, e.g., "eğim-di" (rounding), the novel test word was the vowel-disharmonic counterpart of that word, "eğim-dü"; if the habituated word had been a vowel-disharmonic one, e.g., "yaylım-e" (backness), the novel test word was the vowel-harmonic counterpart of that word, "yaylım-a", respectively (see Table 2). Using novel as well as old items in the test phase allowed us to observe whether infants dishabituated upon hearing the novel word as compared to the old words in the test phase (Oates, 2007). By including

old words in the test phase, we could also check whether habituation of the old word continued with respect to the habituation phase.

Experiments lasted 5 minutes on average. The experiment was terminated at any point during habituation or test if the infant cried, became sleepy or inattentive for some other reason. After the experiment, pictures of the infant with a doctoral cap were taken and a "diploma" as "Baby Scientist" was awarded to them.

After the family's visit infants' listening times were re-coded off-line from the videos by two experienced coders, in order to obtain inter-rater reliability. All data was re-coded thus, accepting only reliability scores > .90.

2.4. Auditory Stimuli

Auditory stimuli were Turkish vowel-harmonic and vowel-disharmonic stem-suffix sequences. Out of an original pool of 180 stem-suffix sequences six items for backness harmony and six items for rounding harmony were selected, according to a pre-study conducted with adult speakers of Turkish (cf., Hohenberger et al., 2016). All stems were infrequently used in Turkish, according to a Turkish frequency dictionary (Göz, 2003), to avoid the possibility of confounding due to stimulus familiarity. Stems could be 1-3-syllabic; suffixes 1-2-syllabic. Table 2 below presents the exhaustive set of stimuli used in this study:

Table 2: Stem-suffix sequences for backness and rounding harmonies

BF-straight	BF-reverse	RU-straight	RU-reverse
zeybek-ten	zeybek-tan	uyluk-suz	uyluk-sız
yalpak-ta	yalpak-te	zındık-tı	zındık-tu
üfleç-te	üfleç-ta	eğim-di	eğim-dü
yeltek-çe	yeltek-ça	göver-lik	göver-ük
yaylım-a	yaylım-e	neferim-si	neferim-sü
vantuz-a	vantuz-e	bayır-mış	bayır-muş

Stimuli were spoken by a female native speaker of Turkish and recorded in the Media Lab of Middle East Technical University (METU). Each token had a length of about 1 s (M=1.0075, SD=0.0210).

3. Results
3.1. Habituation

A Mixed Linear Effect (MLE; Heck, Thomas, & Tabata, 2014) model was carried out with age (6, 10 months), and trial (1-6) as fixed repeated factors. Note that not all infants contributed to both points in time. Note also that only six trials were analyzed in the habituation phase although infants could have experienced a variable number of trials (up to ten). We only considered the first three (F1-3) and the last three (L1-3) habituation trials. Harmony-type (backness, rounding) and direction of habituation (straight, reverse) were fixed between-subjects factors.

Overall, 50% of infants habituated, 47% of the 6-month-olds and 53% of the 10-month-olds. Here, we will consider them together, as one group only.

Results revealed a main effect of age ($F(1,502.36)=12.18$, $p=.001$). 6-month-olds looked significantly shorter ($M=10.05s$, $SE=0.59$) than 10-month-olds ($M=12.37$, $SE=0.54$). Furthermore, there was a main effect of trial ($F(5,364.18)=14.17$, $p<.001$). Listening times decreased monotonously over the course of the six trials (F1: $M=16.50$, $SE=0.85$; F2: $M=13.92$, $SE=0.84$; F3: $M=12.17$, $SE=0.84$; L1: $M=8.57$, $SE=0.84$; L2: $M=8.43$, $SE=0.83$; L3: $M=7.66$, $SE=0.83$). Overall, listening times of the first three trials (F1-3) were significantly longer than over the last three trials (L1-3), see Figure 3. Other significant effects are not reported here since they are unrelated to the main focus of the study.

3.2. Test

The test phase comprises two novel items (N1,2), namely the disharmonic or harmonic counterparts of the habituated harmonic or disharmonic words. We compared listening times between the two novel and the two old words rather than between the last habituation trial (L3) and the first test trial (N1). We did this for two reasons: (1) overall, infants still seemed to continue habituating to the old word, as can be seen from the further decrease in listening times for O1 and O2, and (2) because the difference between old and novel words, which was only in terms of the features [back-front] or [round-unround], respectively, was quite subtle and furthermore occurred in the suffix at the end of the word, and therefore required fine discrimination abilities. The comparison between novel and old items in the test phase therefore seemed to be a more sensitive measure of discrimination as the comparison between L3 and N1 (Oates, 2010). Age (6, 10 months), test type (novel, old), and trial (1,2) were fixed repeated factors and harmony type (backness, rounding) and direction (straight, reverse) were fixed between-subject factors.

Results revealed a main effect of test type (novel, old) ($F(1,204.74)=7.58$, $p<.01$). Overall, infants listened longer to novel words ($M=8.52$, $SE=0.48$) as compared to old words ($M=7.21$, $SE=0.48$).
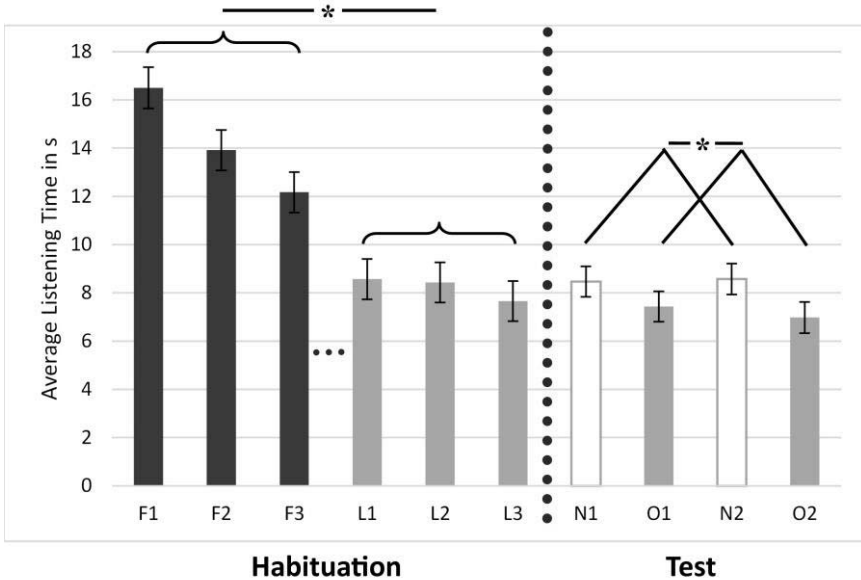
Figure 3. Habituation and Test phases: Overall, infants' listening times decreased between the first three (F1-3) and the last three (L1-3) habituation trials. In the test phase, novel words (N1,2) elicited reliably longer listening times than old words (O1,2).

3.3. ANCOVA – Test

Whether or not infants discriminated between novel and old words crucially depends on the level of habituation before test (Oates, 2010; Turk-Browne et al., 2008). Infants' decline of listening times at the end of the habituation phase differs inter-individually. We therefore captured individual levels of listening time by averaging over the last three habituation trials (L1-3). We then re-analyzed the test phase with these averages as covariate. This Analysis of Covariance (ANCOVA) revealed a significant effect of the covariate ($F(1,118.92)=10.82$, $p=.001$). The average listening time of the last three habituation trials was $M=8.34$ s. The previously found effect of test type, i.e., the difference between novel and old words, vanished in the ANCOVA, however, re-emerged in two three-way interactions, showing complex inter-relations with the other factors in the design. First, there was a significant three-way-interaction between age*direction*test type ($F(1,209.60)=3.92$, $p<.05$). 6-month-old infants, on the one hand, discriminated novel ($M=9.88$, $SE=0.86$) and old words ($M=7.04$, $SE=0.89$) only when habituated with a disharmonic word (reverse condition) but listened to novel ($M=7.43$, $SE=1.07$) and old words ($M=7.82$, $SE=1.06$) equally long when habituated with a harmonic word (straight condition). 10-month-olds, on the other

hand, discriminated novel and old words in either condition: when habituated with a harmonic word, they listened longer to the new (disharmonic) word (M=7.65, SE=0.83) as compared to the old word (M=6.09, SE=0.82); likewise, when they were habituated with a disharmonic word, they also listened longer to the new (harmonic) word (M=8.29, SE=0.83) as compared to the old word (M=7.20, SE=0.84), see Figure 4:
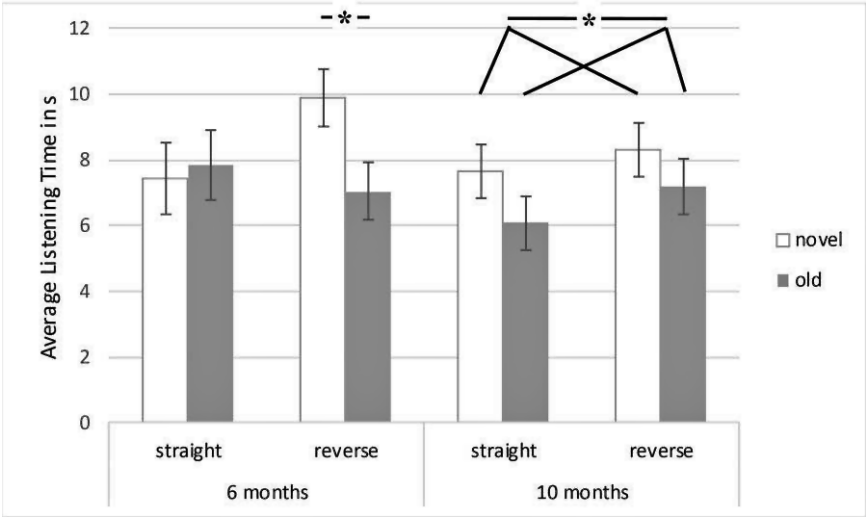

Figure 4. ANCOVA: 3-way-interaction between age*direction*test type

Second, there was a significant three-way-interaction between age*test type*trial (F(1,262.41)=4.59, p<.05). 6-month-olds, on the one hand, discriminated novel (M=9.49, SE=0.90) from old words (M=7.48, SE=0.89) only in the first trial pair but listened equally long to novel (M=7.83, SE=0.90) and old words (M=7.38, SE=0.94) in the second trial pair. 10-month-olds, on the other hand, did not discriminate novel (M=7.05, SE=0.79) from old words (M=7.13, SE=0.78) in the first trial pair but discriminated novel (M=8.89, SE=0.79) from old words (M=6.16, SE=0.80) in the second trial pair, see Figure 5:
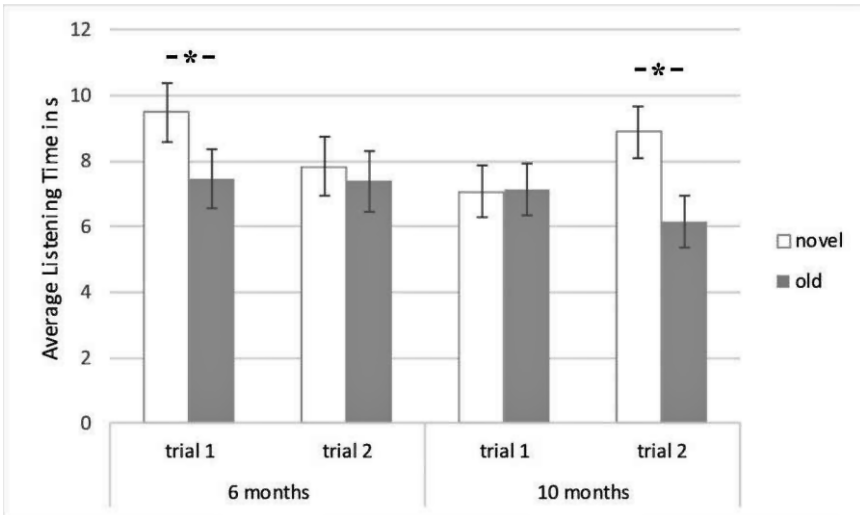
Figure 5. ANCOVA: 3-way-interaction between age*test type*trial

4. General Discussion

The analysis of the habituation phase revealed that 50% of all infants habituated, suggesting a heterogeneous composition. Furthermore, habituation to the old stimulus seems to continue throughout the test phase as evidenced by further decreasing listening times to old words. However, overall, the entire sample showed a significant decrease between the first and the last three habituation trials. Taken together, these findings indicate that despite individual differences in levels of habituation and signs of ongoing habituation in the test phase, infants had processed the crucial information during the habituation phase to a sufficient degree. Moreover, we found that older infants listened reliably longer to the habituation stimuli than younger infants. This is a somewhat unexpected result. Usually, older infants are more efficient in information processing and thus need less time to encode that information, as compared to younger infants (Colombo & Mitchell, 2009). However, other factors may have reverted this relation. In this respect, consider that the word specimens to be distinguished in our study vary only very slightly, in exactly one phonological feature, from [+back] to [- back] or vice versa or from [+round] to [-round] or vice versa. Moreover, our stimuli are structurally complex and harmony relations have to be construed between stems and suffixes. Possibly, older infants are more advanced in their language development and process the stimuli at a deeper, phonological, level and consequently listen to them longer.

The analysis of the test phase revealed a novelty preference, i.e., overall, infants listened significantly longer to novel as compared to old words. This novelty preference constitutes the major finding of the present study. It yields

unambiguous evidence that monolingual Turkish infants from 6 months onwards are capable of discriminating word pairs on the basis of phonological features that are implied in Turkish backness and rounding vowel harmony. This finding is also relevant with respect to the question whether infants reached satisfying levels of habituation before test. As is known in the literature, habituated infants tend to show a novelty preference, whereas non-habituated infants tend to show a familiarity preference (Aslin, 2007; Colombo & Mitchell, 2009; Oates, 2010; Turk-Browne et al., 2008). Our finding of an overall novelty-preference suggests that even non-habituated infants had extracted the relevant features.

In the ANCOVA, more complex interrelations between the novelty effect, age, trial, and direction of habituation were observed, taking into account individual levels of habituation. First, infants' discrimination ability depended on the direction of habituation. 6-month-old infants only discriminated when they had been habituated to the disharmonic word and then, in the test phase, heard the harmonic one as the novel word. However, 10-month-old infants discriminated in both directions. The response pattern of the younger infants in this study is reminiscent of an earlier finding of Mehler, Jusczyk, Lambertz, Halsted, Bertoncini, & Amiel-Tison (1988) who studied the discrimination of their native vs a foreign language in neonates (by using sucking-rate). They found that French newborns were able to discriminate French from Russian on the basis of prosody only when they had been habituated to Russian and then heard French (RF) as the novel language in the test phase but not if they were habituated to French and heard Russian as the novel language in the test phase (FR, Exp. 1). They argued that the familiarity effect, i.e., the preference for the native language, interacted with the novelty effect, the preference for the non-native language, such that in the FR condition the familiarity effect canceled out the novelty effect whereas in the RF condition, the familiarity and the novelty effect added to each other: the postshift stimulus was not only new but also from the preferred language (p. 150). A similar effect may have occurred in our 6-month-olds. Our older infants, in contrast, differentiated equally well in both directions, indicating more general discrimination abilities. Taken together, these findings show that discrimination abilities develop gradually, emerging first in favourable and only somewhat later in less favourable conditions as well. Second, the locus of discrimination in the test phase depended on infants' age. While 6-month-olds discriminated only in the first trials pair, 10-month-olds discriminated only in the second trial pair. 6-month-olds' discrimination of the first novel word after long exposure to the familiar word is expected. When encountering the second novel word, habituation to that word may have set in already, resulting in decreased listening times comparable to the old word. However, it is surprising that older infants should not catch the crucial contrast at the first opportunity but only at the second one – then, however, with particular clarity. This phenomenon may indicate that older infants were satiated at the end of the habituation phase and were thus not susceptible to the novel, contrastive word. Alternatively, it might be the local contrast between the first novel and the first old word in the test phase that led to increased listening times of the first old word, hindering the difference to become significant

(Colombo & Mitchell, 2009). In the second test trial pair, however, sensitization for the novel word may have occurred. Sensitization is a competing process to habituation (Sirois & Mareschal, 2004, p. 1353; cf. Colombo & Mitchell, 2009). Whereas habituation leads to a decrease of attention to the stimulus, sensitization leads to an increase of attention, especially in early phases of (dis)habituation. Older infants may thus have become sensitized to the novel stimulus in the second test trial pair, paying enhanced attention to it.

5. Conclusion

The present study using a habituation paradigm revealed that monolingual Turkish infants from 6-months onwards discriminate harmonic from disharmonic words, for backness and rounding harmony. When listening behaviour in the habituation phase was taken into account, 10-month-olds showed generalized discrimination abilities as compared to 6-month-olds who discriminated only when familiarity and novelty effects overlapped in the critical novel test stimulus. Moreover, 10-month-olds showed local contrast effects and sensitization in the course of the test phase, manifesting several attentional shifts throughout the test phase. We suggest that in future research even younger infants might be tested. Furthermore, the use of vowel harmony as a segmentation cue, along with stress information, should be studied.

References

Aksu-Koç, Ayhan, & Slobin, Dan I. 1985. The acquisition of Turkish. In Dan I. Slobin (Ed.), *Cross-linguistic Study of Language Acquisition Volume 1*, (pp. 839-878). Hillsdale, NJ: Erlbaum.

Altan, Aslı 2009. Acquisition of vowel harmony in Turkish. In S. Nalan Büyükkantarcıoğlu & Emine Yarar (Eds.), *35. yıl Yazıları*, (pp. 9-26). Multilingual Yabancı Dil Yayınları.

Aslin, Richard N. 2007. What's in a look? *Developmental Science* 10(1), 48-53.

Clements, George N. & Sezer, Engin 1982. Vowel and consonant disharmony in Turkish. In Harry van der Hulst, & Norval Smith (Eds.), *The Structure of Phonological Representations, Part II*, (pp. 213-255). Dordrecht: Foris.

Colombo, John, & Mitchell, D. Wayne 2009. Infant visual habituation. *Neurobiology of Learning and Memory, 92*, 225-234.

Ekmekçi, Özden 1979. *Acquisition of Turkish: A longitudinal study on the early language development of a Turkish child*. PhD dissertation, The University of Texas at Austin.

Göz, İlyas 2003. *Yazılı Türkçenin Kelime Sıklığı Sözlüğü*. Ankara: Türk Dil Kurumu Yayınları: 823.

Heck, Ronald H., Thomas, Scott L., & Tabata, Lynn N. 2014. Multilevel and longitudinal modeling with IBM SPSS. Second edition. *Quantitative Methodology Series*. NY, London: Routledge.

Hohenberger, Annette, Altan, Aslı, Kaya, Utku, Köksal-Tuncer, Özgün & Avcu, Enes 2016. Sensitivity of Turkish Infants to Vowel Harmony: Preference Shift from Familiarity to Novelty. In Nihan Ketrez, & Belma Haznedar (Eds.), *Studies in L1 Acquisition in Turkish*, (pp. 29-56). John Benjamins Publishing.

Horowitz, Frances D. 1975. Visual attention, auditory stimulation, and language discrimination in infants. *Monographs of the Society for Research in Child Development, 39*(5-6), Serial No. 158.

Kabak, Barış 2011. Turkish vowel harmony. In M. van Oostendorp, C. Ewen, B. Hume, & K. Rice (Eds.), *The Blackwell Companion to Phonology*, (pp. 2831-2954). Wiley-Blackwell.

Kabak, Barış, Maniwa, Kazumi, & Kazanina, Nina 2010. Listeners use vowel harmony and word-final stress to spot nonsense words: A study of Turkish and French. *Journal of Laboratory Phonology, 1*, 207-224.

Kabak, Barış, & Weber, Silke 2013. Markedness, context, and directionality in Turkish harmony: A corpus study on vowel co-occurrence patterns. *Dilbilim Araştırmaları Dergisi, 1*, 53-85.

Ketrez, Fatma N. 2013. Harmonic cues and speech segmentation: A crosslinguistic study on child-directed speech. *Journal of Child Language, 41*(2), 439-461.

Mehler, Jacques, Jusczyk, Peter, Lambertz, Grislaine, Halsted, Nilofar, Bertoncini, Josiane, & Amiel-Tison, Claudine 1988. A precursor of language acquisition in young infants. *Cognition, 29*, 143-178.

Mintz, Toby, & Walker, Rachel 2006. *Infants' sensitivity to vowel harmony and its role in word segmentation*. Paper presented at the LSA, January 7, Albuquerque.

Oates, Lisa M. 2010. Using habituation of looking time to assess mental processes in infancy. *Journal of Cognition and Development, 11*(3), 255-268.

Sirois, Sylvain, & Mareschal, Denis 2002. Models of habituation in infancy. *Trends in Cognitive Sciences, 6*(7), 293-298.

Sirois, Sylvain, & Mareschal, Denis 2004. An interacting systems model of infant habituation. *Journal of Cognitive Neuroscience, 16*(8), 1352-1362.

Suomi, Kari, McQueen, James M., & Cutler, Anne 1997. Vowel Harmony and Speech Segmentation in Finnish. *Journal of Memory and Language, 36*, 422-444.

Turk-Browne, Nicholas B., Scholl, Brian J., & Chun, Marvin M. 2008. Babies and brains: Habituation in infant cognition and functional neuroimaging. *Frontiers in Human Neuroscience, 2*, Article 16, 1-11.

van Kampen, Anja, Parmaksız, Güliz, van de Vijver, Ruben, & Höhle, Barbara 2008. Metrical and statistical cues for word segmentation: Vowel harmony and word stress as cues to word boundaries by 6- and 9-month-old Turkish learners. In Anna Gavarró, & M. João Freitas (Eds.), *Language Acquisition and Development*, (pp. 313-324). Newcastle: Cambridge Scholars Publishing.

Zimmer, Karl E. 1967. A Note on Vowel harmony. *International Journal of American Linguistics 33*, 166-171.

Zimmer, Karl E., & Küntay, Aylin C. 2003. Turkish Internal Vowel Harmony Revisited. In A. Sumru Özsoy, Didar Akar, Mine Nakipoğlu-Demiralp, Eser Erguvanlı-Taylan, & Ayhan Aksu-Koç (Eds.), *Studies in Turkish Linguistics,* (pp. 27-33). Istanbul: Boğaziçi University Press.

Proceedings of the 41st annual Boston University Conference on Language Development

edited by Maria LaMendola
and Jennifer Scott

Cascadilla Press   Somerville, MA   2017

Ordering information

To order a copy of the proceedings or to place a standing order, contact: