The Role of Affect Processing on Infant Word Learning

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Abstract

Although infant-directed speech (IDS) supports infant word learning, it is unclear whether such influence is due to the linguistic or social (i.e., positive emotion) cues conveyed. This paper examines the effect of positive affect on infant word learning. 17-month-old infants were tested on their ability to learn novel word-referent pairings produced in happy adult-directed speech (ADS) via a switch task paradigm. Results showed no evidence of word learning, but there was an increased looking time on test to same and switch trials. The level of affect in ADS may not be sufficient to facilitate word learning.

Index Terms: affect, adult-directed speech, infant word learning, switch task paradigm

1. Introduction

Word learning is a challenging task as infants are required to segment novel words from continuous speech and map them on to a referent (e.g., object) within the environment [1, 2]. When adults communicate with infants they often use simplified words, exaggerated pitch, short utterances, pauses in speech, and positive emotion [3, 4, 5]. This infant-directed speech (IDS) enhances infants' ability to process, segment and learn word-referent pairings [3, 6, 7]. Although positive emotion in IDS is assumed to benefit infant language development, its role in the learning of word-referent pairings is unknown as it is usually confounded with the linguistic properties of IDS [8]. Therefore, it is interesting to examine whether positive emotion facilitates word learning in a non-IDS register, specifically happy adult-directed speech (ADS).

Literature has indicated that the modified acoustic characteristics in IDS, such as hyperarticulated vowels, helps infants recognise clauses in speech, distinguish between different speech sounds, and discern boundaries between words in speech [9 - 11]. For example, research [9] has found that the transitional probabilities in IDS helps 7-month-old infants segment nonsense words from partial words, but not in ADS. This suggests that the linguistic features of IDS provides infants with more information about their native language, which helps them perceive, segment and learn words as opposed to ADS.

However, as affect and infant-directedness co-occur [8], there is a need to investigate the role of positive emotion found in IDS on infant word learning. Researchers [12, 13] have argued that the social nature of word learning, which is comprised of emotional cues, may be equally important as the linguistic properties of IDS. Studies [14, 8] have demonstrated that infants' preference for IDS over ADS appears to be related to the heightened positive emotion. Additionally, research [8] has demonstrated that 6.5-month-old infants showed no preference for IDS compared to ADS when affect was matched across both speech registers. Infants preferred happy speech compared to neutral speech, regardless of the speech register [8]. This suggests that positive emotion may maintain infants' attention and therefore, promote word learning, irrespective of speech register.

So far, researchers [15] have investigated the role of positive emotion within the context of word recognition tasks. For example, a study [15] examined the role of positive affect on word recognition by familiarising 7.5- and 10.5-month-old infants with words presented in happy and neutral affect. During test trials, infants heard familiarised words and unfamiliarised words placed in happy or neutral passages. Results suggest that 7.5-month-old infants attended to the happy passages more than the neutral passages, but were only able to identify the familiar words when affect in test trials were identical to familiarisation. 10.5-month-old infants were able to recognise happy familiarised words but not neutral familiarised words, regardless of test conditions. Additionally, 10.5-month-old infants recognised familiar words when affect was varied across familiarisation and test trials [15]. This suggests that older infants may rely on the affective properties of speech to recognise words across congruent or incongruent passages. Although younger infants were unable to recognise words across unmatched affective passages, the findings nonetheless indicate that emotion, when matched across phases, appears to help younger infants recognise words.

Recently, studies [6, 7] exploring the role of IDS on infant word learning have shown that infants are able to learn novel word-referent pairings presented in IDS, but not in ADS. The age with which IDS continues to support infant word learning has also been investigated. A recent study [7] found that 21-month-old infants learnt novel word-referent pairings better in IDS than in ADS, while 27-month-old infants learnt the pairings in either speech register. Results also showed that 21-month-olds with larger vocabularies learnt the words in either register. This coincides with previous research [2] suggesting that as infants' (18- to 24-months-old) vocabulary increases, they rely less on the properties found in IDS and become more attuned to their native language.

Other researchers [6] have investigated the role of IDS compared to ADS on word learning tasks prior to infants' vocabulary spurt, using a modified Switch Task Paradigm [2]. 17-month-old infants were presented with two same-test trials (i.e., same word-object pairings as in the habituation phase) and two switch-test trials (i.e., violation in word-object

pairings). Longer looking time on switch-test trials determined whether infants had learned the word-object pairings. Results indicated that infants learnt the new word-object pairings when presented in IDS but not in ADS [6]. This suggests that features of IDS seem to support infant word learning. However, it is still unclear whether the linguistic or the social properties present in IDS help young infants learn word-referent pairings.

The current study attempts to explore this idea by disentangling the linguistic (i.e., speech register) and social (i.e., positive emotion) nature of IDS. This will also provide insight into the role of positive affect on word learning as its mechanism is unknown. This was explored by asking the question of whether infants could learn novel word-object pairings presented in happy ADS, using the revised switch task paradigm [5]. It was hypothesised that infants would be able to learn the novel word-object pairings presented in happy ADS.

2. Method

2.1. Participants

The final sample size consisted of nineteen 17-month-old infants (mean age 17.34 months, *SD* = .330, range: 16.89 months to 18.20 months; 8 female). Infants were healthy full-term with no family history of dyslexia, or vision, and hearing difficulties. English was the primary language spoken in the household. An additional 14 infants were tested but excluded from the final sample due to fussiness (n = 8), inattentiveness (n = 2), technical sound issue (n = 1), missing data (n = 1), and failure to habituate (n = 2). Infants were recruited from the MARCS BabyLab database.

2.2. Stimuli and Apparatus

The two isolated words *gabu* and *timay* were produced in happy ADS by a female native English speaker, with prior experience recording IDS and ADS. Thirty-three adult ratings indicated that the words were perceived as happy and spoken in an adult-directed register. Each word consisted of a four-token sequence parted by an 800 millisecond gap of silence. In total, 16 repetitions of each word occurred for a maximum duration of 20 seconds per trial. The labels were used in the habituation and testing phase.

The novel word *lard* [16] was used in the pre- and post-test trial. The word consisted of a 10 token sequence interspersed by a one second gap for a duration of 20 seconds per trial. The pre- and post-test trials were used as a measure of attention. This was explored by examining infants' looking time when presented with a larger acoustic-phonetic change in an auditory label and its associated referent at the start and end of testing session.

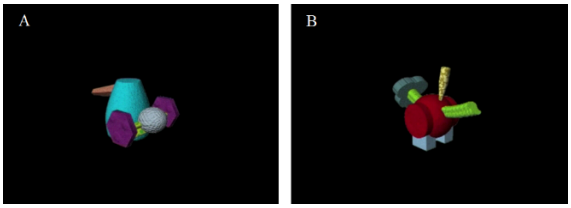

Figure 1. *Image A- Object 1 paired with gabu; Image B- Object 2 paired with timay.*

As shown in Figure 1, the two novel objects [17] paired with the labels *gabu* and *timay* were 3D multi-coloured images, distinct from one another. The word *gabu* was attached to Object 1 (see Figure 1A) and the word *timay* was attached to Object 2 (see Figure 1B). Both novel objects moved back and forth across a black background screen for 20 seconds. The objects' movements were not connected to the spoken words. Both objects were used in the habituation and test phase. A toy waterwheel was presented with the novel word *lard* and was used for the pre- and post-test trials.

Testing was carried out in a small quiet dimly lit laboratory room. A 13.8" monitor was positioned 33.5" in front of the infant. The auditory stimuli were presented at 65 dB ± 5dB amplitude from the infants' seating position. Each testing session was recorded for the purpose of consistent coding and to observe infants' gaze. The experiment was programmed and controlled on the software program Habit X 1.0 on a MacBook Pro laptop. Infants' visual gaze was monitored and recorded using Habit X in an observation room.

2.3. Procedure

Infants were tested separately and sat on their parents' lap. Parents were instructed to not direct the infants' attention back to the screen. As a control, parents were required to listen to music through a cordless headset. In this experiment, a revised version of the switch task paradigm [6] was employed.

Prior to the beginning of each trial, an attention-getting stimulus played to direct the infant's attention to the centre of the screen. Testing session commenced with the pre-test trial, where infants were presented with the novel word *lard* and its associated referent. Following this was the habituation phase during which infants viewed the two word-object pairings separately in a pseudo-randomised order, with no pairing appearing more than twice in a row. This pseudo-randomised order was identical for all infants. The experimenter pressed a key when the infant's gaze was fixated on the screen, and released the key when the infant looked away. The trial continued to play until the infant diverted his or her attention away from the screen for 1 second or a maximum of 20 seconds. The trials ended once the infant had habituated. This was determined by a habituation criterion defined as a 50% reduction in looking time on the last three trials compared to the first three trials. If the infant did not meet this criterion, they viewed a maximum of 25 habituation trials and were excluded from the final sample.

During the test trials, infants were presented with two types of test trials; same-test and switch-test trials. In the same-test trials, infants viewed the same word-object pairings as in the habituation phase. In the switch-test trials, infants were presented with a violation in word-object pairings (e.g., Object 1 paired with *timay*). There were two blocks of test trials which consisted of two same-test trials and two switch-test trials. For half of the infants the initial test block consisted of two same-test trials followed by two switch-test trials. For the other half of infants this order was reversed. This initial test block was then repeated for all infants. The order of the word-pairings in these test trials was counterbalanced across infants. After completing the test trials, infants were exposed to the post-test trial (identical to the pre-test trial).

3. Results

To test the prediction that infants were able to learn word-object pairings in happy ADS, a 2 x 2 (block x test trials)

factorial repeated measures ANOVA, with alpha set at .05, was performed on the mean looking time of same-test trials versus switch-test trials. As can be seen in Figure 2, there was no evidence of looking time differences in the first block of test trials compared to the second block of test trials, $F(1, 18) = 1.855$, $p = .190$, $\eta_p^2 = .093$. Figure 2 also shows no indication of a difference in looking time on same-test trials compared to switch-test trials, $F(1, 18) = 1.347$, $p = .261$, $\eta_p^2 = .070$. There was no interaction between blocks of trials and test trials, $F(1, 18) = .000$, $p = 1.000$, $\eta_p^2 = < .001$. These results indicate an absence of evidence of word learning in happy ADS.

A dependent-samples *t* test did not reveal a difference in average looking time on the pre-test trial ($M = 18.14$, $SD = 1.53$) compared to the post-test trial ($M = 18.35$, $SD = 1.66$), $t(18) = -.355$, $p = .726$, 95% CI [-1.419, 1.008]. This indicates that infants' level of attention was the same from the beginning to the end of the testing session. The average number of trials to reach the 50% habituation criterion was 10 trials ($SD = 4.94$), and the average total looking time to reach habituation was 98.35 seconds ($SD = 53.22$).

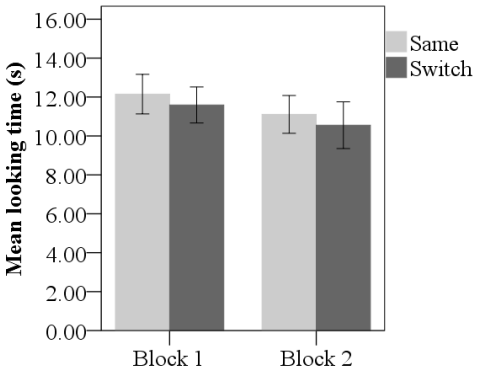

Figure 2. *Mean looking time on same-test trials versus switch-test trials across test blocks. (Error bars represent +/- SEM)*

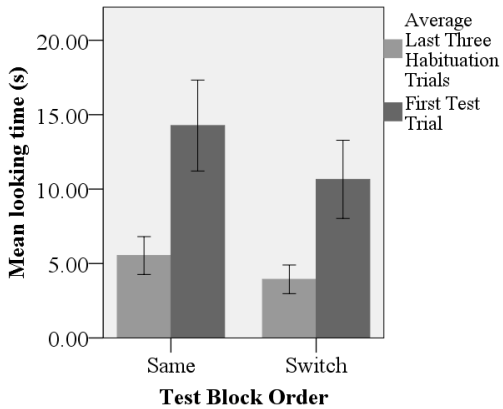

Figure 3. *Looking time on the last three habituation trials (averaged) to the first test trial. (Error bars represent +/- SEM)*

To explore why there may have been no difference between same and switch test trials, a mixed repeated factorial ANOVA, with alpha set at .05, was performed on the average looking time on the last three habituation trials compared to the first test trial, across test blocks. As can be seen in Figure 3, infants showed a significant increase in looking time on the first test trial compared to the last three habituation trials, $F(1, 17) = 84.210$, $p = < .001$, $\eta_p^2 = .832$. There was no difference between the presentation of test trials (same-test or switch-test) across the test blocks, $F(1, 17) = 3.993$, $p = .062$, $\eta_p^2 = .190$. An interaction effect was not found between the test phases and order of presentation in test trials, $F(1, 17) = 1.438$, $p = .247$, $\eta_p^2 = .078$. The results indicate that infants showed renewed interest to the word-referent pairings from the habituation phase to the test phase, regardless of the order of presentation.

4. Discussion

Previous studies [6, 7] evaluating the role of IDS showed that younger infants were able to learn novel word-referent pairings in IDS, but not in ADS. The main objective of this study was to examine the role of positive emotion in the context of learning word-referent pairings by using an ADS register. Against our initial hypothesis, results with 17-month-old infants demonstrate an absence of evidence when learning the word-object pairings presented in happy ADS. The null result was unexpected, as previous work [6, 2] using the switch task paradigm has shown robust effects in infant word learning.

Further inspection of the results suggests that the lack of statistical evidence may be due to a dishabituation effect occurring between the last three habituation trials and the first test trial, regardless of the test block infants were presented with. The reason of this effect is unclear. One possibility is that infants' fast pace of habituation (i.e., brief exposure to the word-referent pairings) might have led to a zone of familiarity preference during the test trials [18]. This might have compromised the results since infants looked longer in the same-test condition. Despite a decrease in looking time in the habituation phase, infants might not have habituated. Rather, infants were drawn to the familiarity of the word-object pairings which extended renewed interest during test phase resulting in sensitised looking time between the same- and switch-test trials. Further investigations are needed to disentangle the effect of the dishabituation.

Alternatively, it may be argued that infants primarily rely on the linguistic and structural properties of IDS to learn new words as it provides more information about the structural patterns of their native language than positive emotion [9, 10, 19]. In agreeance, studies [6, 7] have demonstrated that infants are able to learn novel word-referent pairings when the words are produced in IDS, but not in ADS. However, others [12, 13] have argued that infants not only rely on the linguistic properties, but also the social and emotional cues conveyed in speech to learn new words. Accordingly, prosody not only refers to the linguistic structure of language, but also to the paralinguistic information such as intention and emotion, which convey meaning about language [20].

This may possibly indicate that happy ADS in the present design was not effective under the conditions tested (i.e., infants looked similarly to the same- and switch-test trials). Positive emotion in the current study was not matched to the level of positive emotion found in IDS, or in previous research [e.g., 8]. For example, studies [8] have found that infants do not prefer an infant-directed or adult-directed register when affect is matched. Rather, infants prefer happy speech compared to neutral speech. This indicates that infants might prefer the heightened positive emotion present in IDS [14], as

they rely on its saliency to help detect, process and encode certain speech in their native language. This explanation is further strengthened by studies [15] demonstrating that positive emotion helps infants recognise certain words produced in passages. Additionally, studies [21] have shown that adults remember emotionally charged words more than neutral words. While the current study did not show evidence of word learning, the present discussion is noteworthy as it suggests that expressive communication may encourage attentional processing and word learning.

The view that positive affect may encourage word learning is strengthened by studies [22, 23] exploring maternal depression and infant language and cognitive development. Studies [22, 23] investigating IDS produced by mothers with clinical depression suggest that a deficiency in emotional communication may cause deficits in language development, as infants are less likely to employ associative learning strategies. A recent study [22] examined whether there was a correlation between maternal depression and infant language and cognitive development. Results showed that an absence of expressive communication correlated with deficits in infant cognitive development. This suggests that the positive emotion found in IDS appears to play an important role in regulating and encouraging language and cognitive development.

A limitation of this research is that an IDS condition was not employed to compare with the current happy ADS condition. This could have provided possible reasons as to why infants showed no evidence of word learning. Affect could have been matched and compared to an IDS condition to investigate whether positive emotion encourages word-referent learning. Future research should explore this and also test happy ADS to a neutral IDS condition. This could help explain the mechanism of positive emotion and provide additional information on whether infants rely on the linguistic and social properties of IDS mutually or separately to learn words.

5. Summary and conclusion

The study is important to current research on early word learning as minimal research has investigated the role of positive affect supporting infant learning of word-referent pairings. This was explored by disentangling the linguistic and social nature of IDS. An important implication of this study is that IDS, to some extent, appears to maintain certain intrinsic features which separates it from ADS. It is, therefore, interesting to continue exploring the role of positive emotion found in speech on infant word learning, particularly as previous research suggests that positive emotion may be an important feature facilitating language development.

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