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LuCiD Work Package number **3**
Project: Infant Directed Speech and face perception

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Country: United Kingdom; Lancaster University BabyLab - Department of Psychology

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Methods, Procedure and Data Analysis

This section is from Sirri, L., Linnert, S., Reid, V. & Parise, E. (2020). Speech Intonation Induces Enhanced Face Perception in Infants. *Scientific Report, 10,* 3225.

Participants

In Experiment 1, thirty-five infants took part in the study: 18 infants (mean age: 144.78 days; range: 115 to 177 days; 5 female) contributed to the auditory ERP analysis, and 19 infants (mean age: 146.47 days; range: 115 to 177 days; 5 female) contributed to the visual ERP analysis. In Experiment 2, thirty-one infants took part in the study: 18 infants contributed to the auditory ERP analysis (mean age: 135.61 days; range: 117 to 161 days; 5 female) and 18 infants contributed to the visual ERP analysis (mean age: 136.06 days; range: 117 to 162 days; 3 female). In both experiments the majority of the infants were included in both auditory and visual ERP analysis (Experiment 1: $n = 16$, Experiment 2: $n = 16$; see Supplemental Information for analyses on these subsets of participants). However, some infants contributed enough artifact free segments only in the auditory (Experiment 1: $n = 2$, Experiment 2: $n = 2$) or only in the visual (Experiment 1: $n = 3$, Experiment 2: $n = 2$) condition. All additional participants were not included in the statistical analyses due to an insufficient amount of artifact free trials or technical issues.

All infants were born healthy (≤37 weeks of gestation), and were recruited from a database of parents from the local area who expressed an interest in taking part in developmental research studies. Parents were informed about the aim of the study and gave informed written consent before participation. Infants received a book for their participation. The study was conducted in conformity with the declaration of Helsinki and approved by the University Research Ethics Committee, at Lancaster University.

Stimuli

In both experiments, the auditory stimuli were the same as in Senju and Csibra (2008), shared by the senior author: the greeting word "*hello*" uttered by a female voice in either IDS or ADS. Audio files were digitized and edited with Adobe Audition (CS 5.5), at 16-bit resolution and 44 kHz sampling rate. The speech had different length, 580 ms for ADS and 720 ms for IDS, but primarily differed in pitch

and intensity. The mean intensity of speech was 75 dB for ADS and 85 dB for IDS. Auditory stimuli were delivered through loudspeakers located behind the monitor.

Visual stimuli consisted of 9 color photographs with a white background, portraying white female adult faces with a neutral expression selected from the NimStim repository (Tottenham et al, 2009). The authors shared the visual stimuli, including instructions as to which faces from their repository can be used in our study and for publication. Each picture measured 355 ×x 473 pixels. At the viewing distance of 60 cm from a 19-inch CRT monitor, each picture subtended horizontal and vertical visual angle of 16.1° and 21.7°, respectively. In Experiment 2 we used the same pictures, but rotated at 180° (examples on Fig. 2).

Procedure

Infants sat on their parents' lap throughout the whole experiment. Mothers were instructed not to talk to their infants during the presentation of the stimuli. Each trial consisted of an auditory and a visual stimulus and the experiment consisted of one block including 108 trials, 54 trials in each ADS and IDS condition. All stimuli were presented with Matlab® (v. 2014b), using PsychToolBox functions and custom-made scripts. Each trial started with a central dynamic visual attention grabber swirling on a grey background for 2150 ms, after which it froze while the auditory stimulus ("*hello*") was played. The attention grabber was centred on the screen. Then the attention grabber disappeared, and a face appeared on the screen, with the eyes located in the region previously occupied by the attention grabber. The stimulus onset asynchrony between the auditory and visual stimuli was randomized between 1050 and 1250 ms. The face remained on the screen for 1000 ms. During the inter-trial interval, the grey screen remained blank for a random period varying from 1000 to 1200 ms. To further attract infants' attention during the experiment, there were 6 different dynamic attention grabbers, changing every 6 trials. The presentation order of the conditions was randomised, and trials were presented as long as the infant was attentive. If the infant lost interest, an animated spiral and a jingle were presented to reorient attention to the presentation screen. If the infant became fussy, the animated spiral was played again or the experimenter gave a short break and played with the baby. The session ended if the infant was no longer attracted to the screen. The whole experiment lasted approximately 15 minutes and was video-recorded for offline data editing purposes.

EEG recording and analysis

The EEG was continuously recorded using a 124-channel Hydrocel Geodesic Sensor Net, referenced online to the vertex (Cz). The EEG signals were amplified via an EGI NetAmps 400 amplifier, digitized at 500 Hz sampling rate with a 200 Hz lowpass filter. Offline the EEG was filtered between 0.3–30 Hz. The 150 ms of silence at the begin of both audio files were compensated, and EEG signals in response to auditory stimuli were segmented into 1050 ms epochs including 200 ms before stimulus onset and 850 ms post stimulus onset. EEG in response to visual stimuli were segmented into 1200 ms epochs including 200 ms before stimulus onset to 1000 ms post stimulus onset.

Both automatic and manual artifact detection were executed. Bad channels were automatically rejected if the average amplitude of an 80 ms gliding window exceeded ±150 μV. In addition to the automatic artefact detection, each individual epoch was visually inspected and further epochs or channels were included or rejected. Segments containing eye-blinks or eye-movements or more than 13 bad channels (<10% of all electrodes) were rejected. During the visual inspection of the data, EEG segments time locked to the speech were processed first and did not require the infant to attend towards the following visual stimulus. Segments time locked to the face were excluded if the video recording showed that the infants did not attend towards the stimuli. Bad channels of included segments, that is segments with less than 13 bad channels (10%), were replaced using spherical spline interpolation. To compute the ERPs we averaged auditory and visual segments separately, for each participant and each condition, resulting in 2 auditory ERPs (ADS or IDS) and 2 visual ERPs (faces preceded by ADS or IDS). All ERPs were re-referenced to an average reference and baseline corrected to the 200 ms pre-stimulus onset. Previous infant EEG studies have observed reliable and interpretable data in as few as 7 trials per condition (Kaduk, Elsner & Reid, 2013; Stets & Reid, 2011). Here, the minimum number of artifact free trials for inclusion was 8 per condition, both for the auditory and the visual ERPs. In Experiment 1, the mean number of artifact free trials for auditory ERPs was 18 (ranging from 9 to 39) in ADS and 17 in IDS (ranging from 8 to 31) condition. For the visual ERPs, the mean number of artifact free trials was 17 (ranging from 9 to 36) in ADS and 17 in IDS (ranging from 8 to 32) condition. In Experiment 2, the mean number of artifact free trials for auditory ERPs was 20 (ranging from 8 to 39) for ADS and 20 (ranging from 9 to 37) for IDS. For the visual ERPs the mean number of artifact free trials was 20 (ranging from 8 to 39) for ADS and 21 (ranging from 11 to 41) for IDS.

Based on previous findings (Parise & Csibra, 2013; Zangl & Mills, 2007), we identified the time windows from 200 to 400 ms and 600 to 800 ms for responses to speech stimuli, over both the fronto-central and temporal recording sites. For the fronto-central area, we averaged the mean amplitudes of 12 channels (4, 5, 6, 11, 12, 13, 19, 20, 24, 112, 118 and 124), approximately corresponding to the F3, F4, Fz, C3 and C4 locations in the 10–20 system. For the temporal areas, we averaged the mean amplitudes of 3 channels over the left (58, 59 and 65, corresponding to the T5 area) and over the right (90, 91, 96 corresponding to T6) recording sites (Fig. 1).

For the visual stimuli, we analyzed the P1 (100 to 200 ms), the N290 (200 to 300 ms) and the infant specific Nc component (300 to 600 ms) related to the allocation of attention (Pönkänen et al, 2011; Reynolds & Richards, 2005). For the P1 and N290 component we averaged the mean amplitudes over the left (channels: 65, 66, 69) and right (channels: 84, 89, 90) occipital areas (Farroni et al., 2002; Farroni et al., 2004). For the Nc component, we averaged the mean amplitudes over the frontal-central area (5, 6, 7, 11, 12, 13, 106, 112, and Cz) approximately corresponding to Fz, FCz, FC1, FC2 and Cz in the 10–20 system (Pönkänen et al, 2011; Reynolds & Richards, 2005) (Fig. 2).

References

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Parise, E. & Csibra, G. (2013) Neural Responses to Multimodal Ostensive Signals in 5-Month-Old Infants. *PLoS ONE 8(8)*, e72360.

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Reynolds, G. D. & Richards, J. E. (2005). Familiarization, attention, and recognition memory in infancy: an event-related potential and cortical source localization study. *Developmental Psychology 41(4*), 598–615.

Senju, A. & Csibra, G. (2008) Gaze following in human infants depends on communicative signals. *Current Biology 18*(9), 668–671.

Stets, M. & Reid, V. M. (2011) Infant ERP amplitudes change over the course of an experimental session: Implications for cognitive processes and methodology. *Brain and Development 34*, 325–329.

Tottenham, N. et al. (2009) The NimStim set of facial expressions: Judgments from untrained research participants. *Psychiatry Research 168(3)*, 242–249.

Zangl, R. & Mills, D. L. (2007). Increased brain activity to infant-directed speech in 6- and 13-month-old infants. *Infancy 11*(1), 31–62.

Structure of archive: folders and subfolders

EEG data:

contains filtered (0.3-30 Hz), segmented (separately for visual and auditory stimuli) and cleaned EEG data in EEGlab file format (one .fdt and one .set file for each participant and condition). NetStation files were imported to EEGlab after bad channel replacement, thus the files contain only clean segments that were included in the further analysis. EEG files were re-referenced using the average reference. The EEG files are not baseline corrected!

/Study 1 upright faces/Auditory ERPs/ADS condition – EEG data from 18 infants, EEG time-locked to the appearance of ADS sound
/Study 1 upright faces/Auditory ERPs/IDS condition - EEG data from 18 infants, EEG time-locked to the appearance of IDS sound
/Study 1 upright faces/Visual ERPs/ADS condition - EEG data from 19 infants, EEG time-locked to upright faces preceded by ADS sound
/Study 1 upright faces/Visual ERPs/IDS condition - EEG data from 19 infants, EEG time-locked to upright faces preceded by IDS sound

/Study 2 inverted faces/Auditory ERPs/ADS condition - EEG data from 18 infants, EEG time-locked to the appearance of ADS sound
/Study 2 inverted faces/Auditory ERPs/IDS condition - EEG data from 18 infants, EEG time-locked to the appearance of IDS sound
/Study 2 inverted faces/Visual ERPs/ADS condition - EEG data from 18 infants, EEG time-locked to inverted faces preceded by ADS sound
/Study 2 inverted faces/Visual ERPs/IDS condition - EEG data from 18 infants, EEG time-locked to inverted faces preceded by IDS sound

Participant Information:
includes participant information per experiment (.csv)

Study 1 auditory – participants included in the Auditory ERP analysis
Participant: participant number
Gender: participant gender
Age in Days: participant age calculated in days (difference between date of birth and date of study)

Study 1 visual – participants included in the Visual ERP analysis
Participant: participant number
Gender: participant gender
Age in Days: participant age calculated in days (difference between date of birth and date of study)

Study 2 auditory – participants included in the Auditory ERP analysis
Participant: participant number
Gender: participant gender
Age in Days: participant age calculated in days (difference between date of birth and date of study)

Study 2 visual – participants included in the Visual ERP analysis
Participant: participant number
Gender: participant gender
Age in Days: participant age calculated in days (difference between date of birth and date of study)

Results:
contains the exported mean amplitudes (.csv) and the SPSS output files (.pdf)

/mean amplitudes/auditory exported mean amplitudes.csv: mean amplitudes for auditory ERPs

Header (from left to right)
1. Participant: participant number
2. Study: Study 1 or 2
3. ADS frontal 200-400 ms
4. IDS frontal 200-400 ms
5. ADS frontal 600-800 ms
6. IDS frontal 600-800 ms
7. ADS temporal left 200-400 ms
8. ADS temporal right 200-400 ms
9. IDS temporal left 200-400 ms
10. IDS temporal right 200-400 ms
11. ADS temporal left 600-800 ms
12. ADS temporal right 600-800 ms
13. IDS temporal left 600-800 ms
14. IDS temporal right 600-800 ms

/mean amplitudes/visual exported mean amplitudes.csv: mean amplitudes for visual ERPs

1. Participant: participant number
2. Study: Study 1 or 2
3. ADS N290 left
4. ADS N290 right
5. IDS N290 left
6. IDS N290 right
7. ADS Nc component
8. IDS Nc component
9. ADS P1 left
10. ADS P1 right
11. IDS P1 left
12. IDS P1 right

/SPSS output/Auditory results SPSS output.pdf

Analyses:
Paired t-test: Frontal 200-400 ms
Group 1 (=Study 1) and Group 2 (=Study 2)

Paired t-test: Frontal 600-800 ms
Group 1 (=Study 1) and Group 2 (=Study 2)

Repeated Measures ANOVA: temporal 200-400 ms
Within-subject factors: ADS vs. IDS, Hem (hemisphere: left vs. right)
Group 1 (=Study 1) and Group 2 (=Study 2)

Repeated Measures ANOVA: temporal 600-800 ms
Within-subject factors: ADS vs. IDS, Hem (hemisphere: left vs. right)
Group 1 (=Study 1) and Group 2 (=Study 2)

Cross experimental comparisons:
Repeated Measures ANOVA: temporal 200-400 ms
Within-subject factors: ADS vs. IDS, Hem (hemisphere: left vs. right),
Between subject factor: group (=study)

Repeated Measures ANOVA: temporal 600-800 ms
Within-subject factors: ADS vs. IDS, Hem (hemisphere: left vs. right),
Between subject factor: group (=study)

Repeated Measures ANOVA: frontal 200-400 ms
Within-subject factor: ADS vs. IDS
Between subject factor: group (=study)

Repeated Measures ANOVA: frontal 200-400 ms
Within-subject factor: ADS vs. IDS
Between subject factor: group (=study)

Non-parametric tests:
Wilcoxon signed rank test: frontal 600-800 ms
Group 1 (=Study 1) and Group 2 (=Study 2)

Wilcoxon signed rank test: temporal 600-800 ms
Group 1 (=Study 1) and Group 2 (=Study 2)

/SPSS output/Visual results SPSS output.pdf

Analyses:

Cross experimental comparison:
Repeated Measures ANOVA: Nc
    Within-subject factor: ADS vs. IDS
    Between-subject factor: Group (=Study)

Repeated Measures ANOVA: N290
    Within-subject factors: ADS vs. IDS, Hem (hemisphere: left vs. right)
    Group 1 (=Study 1) and Group 2 (=Study 2)

Cross experimental comparison:
Repeated Measures ANOVA: N290
    Within-subject factors: ADS vs. IDS, Hem (hemisphere: left vs. right)
    Between-subject factor: Group (=Study)

Cross experimental comparison:
Repeated Measures ANOVA: P1
    Within-subject factors: ADS vs. IDS, Hem (hemisphere: left vs. right)
    Between-subject factor: Group (=Study)

Repeated Measures ANOVA: P1
    Within-subject factors: ADS vs. IDS, Hem (hemisphere: left vs. right)
    Group 1 (=Study 1) and Group 2 (=Study 2)

Paired t-test: Nc
    Group 1 (=Study 1) and Group 2 (=Study 2)

Non-parametric tests:
Wilcoxon signed rank test: Nc
    Group 1 (=Study 1) and Group 2 (=Study 2)

Wilcoxon signed rank test: N290
    Group 1 (=Study 1) and Group 2 (=Study 2)

Wilcoxon signed rank test: P1
    Group 1 (=Study 1) and Group 2 (=Study 2)

Stimuli:
contains stimuli included in the 2 EEG studies
/Auditory: contains auditory stimuli (the word “Hello” uttered in adult-directed speech)
/Visual: contains visual stimuli (female faces) from NimStim repository (Tottenham, N. et al. (2009). The NimStim set of facial expressions: Judgments from untrained research participants. *Psychiatry Research, 168(3),* 242–249.). Upright faces were used in Study 1 (/Study 1 Upright), inverted faces were used in Study 2 (/Study 2 Inverted).