Grant reference number, name of project

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LuCiD Work Package number **3**
Project: Word Power

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Data Collection Start: January 2016; End: July 2018
Country: United Kingdom; Lancaster University BabyLab - Department of Psychology

The files in this archive relate to:

Louah Sirri, Ernesto Guerra, Szilvia Linnert, Eleanor S. Smith, Vincent Reid, Eugenio Parise (2020)
Infants' conceptual representations by meaningful verbal and nonverbal sounds

https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0233968

Methods, Procedure and Data Analysis

We selected six objects with basic level nouns and their associated sounds (car, cow, dog, sheep, telephone, train), suitable for both adults' and infants' experiments. The auditory stimuli included spoken words and their associated sounds. A native female speaker recorded the words uttered in neutral and adult-directed speech (ADS); and the associated sounds were selected from the internet. For the infant experiments, a different native speaker recorded the stimuli in infant-directed speech (IDS).
The visual stimuli were images of the objects, selected online.

Adult Experiments (1A & 1B)

1A: Visual Identification Task; replication of Lupyan and Thompson-Schill (2012)

Thirty healthy adults (20 female; age range: 24;10 y to 42;9 y) sat in front of a 19" CRT monitor and were given a gamepad to respond by button-press. On each trial, participants heard either a word (e.g. 'cow') or an associated sound (e.g. cow meowing) while fixating a central black fixation cross on a grey screen, followed by an image. The inter stimulus interval (ISI) was 1000 ms. The images matched the auditory stimulus 50% of the time, and the order of trials was randomised. Each image remained on the screen for 2 seconds, and participants were instructed to respond as fast as possible by pressing a *match* (e.g. cow) or *mismatch* (e.g. telephone) button on a gamepad. The side (left and right buttons) of the correct response was counterbalanced across participants. After every response, participants received an auditory feedback for correct (a beep) or incorrect (a buzz) responses. As the image disappeared, another trial began. Across trials, each of the six objects was preceded by a word and a sound, match and mismatch, and repeated four times, yielding 96 verification trials. The experiment lasted approximately five minutes.

The adult behavioural data was collected through Matlab® (v. 2014b). All incorrect responses were removed prior to analysis. Reaction times (RTs) below 200 ms and above 1500 ms were also excluded. RTs were analysed using *2* (auditory stimulus) x *2* (congruency) analysis of variance (ANOVA) on SPSS (v.22).

1B: Object Recognition Task

Twenty healthy adults sat at 50-70 cm in front of the computer screen. A Tobii X120 eyetracker (Tobii Pro, Stockholm, Sweden) located beneath the screen recorded their gaze at 60 Hz sampling rate. The eye tracker was first calibrated, using a five-point calibration (shrinking blue and red attention grabber) procedure delivered through Matlab® (v. 2013b). The calibration was controlled with a key press and repeated if necessary. Each trial began with the appearance of a black fixation cross centred on a grey screen for 1000 ms after which an auditory stimulus was played, a word (e.g. dog) or a sound (e.g. dog bark), while the fixation cross remained on the screen. The visual stimulus depicting two objects simultaneously – target (e.g. dog) and distractor (e.g. train) – appeared at 1000 ms ISI, and remained on the screen for 2000 ms while the eye tracker recorded participant's gaze. After 2000 ms the image disappeared, and another trial began. The side of target and distractor was counterbalanced, resulting in one block of 24 trials. The experimental block was repeated 4 times, yielding 96 trials in total. The order of trials within a block and across participants was randomised. The experiment lasted approximately 9 minutes.

Infant Experiments (2A, 2B, 2C)

In Exp. 2A, thirty-two healthy 9-month-old infants (15 girls; age range: 8m13d to 9m28d) took part in the study. In Exp. 2B, there were thirty-two 12-month-olds (18 girls; age range: 11m14d to 12m27d), and in Exp. 2C twenty-three 18-month-old (11 girls; age range: 17m14 to 18m21d) infants. An additional forty infants took part in the study but were not included in the final sample due to an insufficient amount of trials per condition (word or sound; *n*=35), no familiarization phase (*n*=1), participating twice (at 9- and 12 months; *n*=1), low birth weight (<2500 kg; *n*=2) or premature (<37 weeks of gestation; *n*=1).

We adapted the procedure from Experiment 1B to infants, by adding a familiarization phase (using slide presentation (Microsoft Office 2016) on an iPad mini (7,9") tablet); and, by increasing the time of the fixation cross on the screen to 3000 ms. During this time, caregivers were encouraged to maintain infants' attention and interest in the task by saying for instance, "*Oh look*!" or "*Look ….".* Infants sat on their caregiver's laps, and caregivers were asked to sit at a 90° angle from their infant to ensure the eye tracker recorded infants' eye movements only, and to facilitate the interaction between trials. Caregivers were also instructed to avoid verbal communication when the auditory and visual stimuli were displayed, pointing to the screen or naming the objects. The visual stimulus remained on the screen for 4.5 seconds while the eye tracker recorded infants' gaze. After 4.5 seconds, the image disappeared, and another trial began. Infants were presented with one block of 24 trials in total. A break was taken when needed, and the experiment lasted approximately 5 minutes.

Exp. 1B and 2 (A, B, & C)

Two areas of interest that matched size and location of the displayed target and distractor images were defined using Matlab® (v. 2014b), and a summary of participants' fixations with their duration and coordinates on the display was produced using the same software (e.g. first fixation duration and its location). After data pre-processing, we calculated fixation proportions for each of the images on the display in both stimulus type conditions (words vs. sounds) using R software (R Core Team, 2018). A value of 1 was given to an object when participants were fixating its region on the display at a given moment, while a value of 0 was given to the other region. If no fixation was detected by the eye tracker, both regions were given a 0 value. We defined fixation proportion as the percentage of looks to an object on each trial and across time. This measure was then aggregated, first by participant and stimulus type, and then into 100 ms time windows.

Structure of archive: folders and subfolders

- Matlab Scripts: includes experimental and data extraction scripts
/WordPower_Infants.m: experimental script (including calibration), used to run Exp. 2A, 2B, & 2C
/WordPower_Adults.m: experimental script (including calibration), used to run Exp. 1B
/WordPower_BehaviouralAdult.m: experimental script used to run Exp. 1A
/FixationReport_Adults.m and /FixationReport_Infants.m: pre-processing data scripts to extract eye movement data collection.

- Stimuli_Eye-Tracking: contains stimuli included in the Adult and Infant eye-tracking studies (Exp. 1B & Exp. 2A, 2B, 2C)
/Adults / Auditory: contains stimuli (words uttered in adult-directed speech) described in Audio Code
/Adults / Visual: contains stimuli described in Image Code
/Infants / Auditory: contains stimuli (words uttered in infant-directed speech) described in Audio Code
/Infants / Visual: contains stimuli described in Image Code

- Stimuli_Behavioural Adult: contains stimuli included in the Adult behavioural study (Exp. 1A)
/Adults /Images: contains the six images of selected objects (car, cow, dog, sheep, telephone, train)
/Adults/Sounds: contains the twelve auditory stimuli presented (used in Exp. 1B)

- Subject Information: includes participant information per experiment
/Exp.1A_SubjectInfo: adult participant information
Subject: participant number
Sex: participant gender
DoB: date of birth
Test Day: date of participation in the study
Age: participant age in years/months/days obtained by calculating the age difference between DoB and Test day
Age Days: participant age calculated in days
Hand: participant handedness
Lang: language(s) spoken by participant (MonoL (=monolingual); BiL (=bilingual); TriL (=trilingual)
Button: counterbalance of gamepad response button

/Exp.1B_SubjectInfo: adult participant information
Subject: participant number
Sex: participant gender
DoB: date of birth
Test Day: date of participation in the study
Age: participant age in years/months/days obtained by calculating the age difference between DoB and Test day
Age Days: participant age calculated in days
Lang: language(s) spoken by participant (MonoL (=monolingual); BiL (=bilingual); TriL (=trilingual)

/Exp.2A_SubjectInfo: 9-month-old infants - participant information
/Exp.2A_SubjectInfo: 12-month-old infants - participant information
/Exp.2A_SubjectInfo: 18-month-old infant - participant information
[Columns A to H – participants included in the final sample; Columns K to P – participants not included in the final sample]
Subject: participant number
Sex: participant gender
DoB: date of birth
DoT: date of test
Weeks: gestational age
Weight: participant weight at birth
Age: age in years/month/days
Age Days: participant age calculated in days

- Project Data:
/Behavioural_Adults / adults_lancaster_response_times.xlsx
Header (from left to right)
1. pp: subject (participant) ID
2. trial: trial number (ID)
3. resp: response (C=congruent (sound-image match); I=incongruent (sound-image mismatch)
4. RT: reaction time (button press on gamepad) in milliseconds
5. feed: feedback (bleep: correct answer (match); buzz: incorrect answer (mismatch))
6. audio: stimulus ID (sound / word)
7. image: stimulus description

/Eye-tracking / 9month_lancaster_eye_movements.xlsx; 12month_lancaster_eye_movements.xlsx; 18month_lancaster_eye_movements.xlsx

Header (from left to right)
1. Subject: subject ID
2. Trial_Num: trial number
3. Fixat_Onset: fixation count
4. Trial_Index: trial ID in milliseconds
5. Fixat_Location: 0=left; 1=right
6. Fixat_Index: fixation ID (the number of fixations within a trial)

7. Image Code	Stimulus	Target - Distractor	**8. Audio** Code	Stimulus
1	car_targetL	car (Left) – sheep (right)	1	Car Sound
2	car_targetR	car (right) – dog (left)	2	Car Word
3	cow_targetL	cow (left) – train (right)	3	Cow Sound
4	cow_targetR	cow (right) – train (left)	4	Cow Word
5	dog_targetL	dog (left) – car (right)	5	Dog Sound
6	dog_targetR	dog (right) – telephone (left)	6	Dog Word
7	sheep_targetL	sheep (left) – telephone (right)	7	Sheep Sound
8	sheep_targetR	sheep (right) – car (left)	8	Sheep word
9	telephone_targetL	telephone (left) – cow (right)	9	Telephone Sound
10	telephone_targetR	telephone (right) – sheep (left)	10	Telephone Word
11	train_tragetL	train (left) – dog (right)	11	Train Sound
12	train_tragetR	train (right) – cow (left)	12	Train Word

9. Fix_Start: start time (in milliseconds) of a fixation in a trial
10. Fix_End: end time (in milliseconds) of a fixation in a trial
11. Fix_Duration: the duration of the fixation in milliseconds (end time minus start time)
12. sound = Audio Code
13. image = Image Code
14. label = Fixat_Location
15. participant = Subjet
16. CURRENT_FIX_START = Fix_Start
17. CURRENT_FIX_END = Fix_End
18. TRIAL_INDEX = Trial_Num

/adults_lancaster_eye_movements.xlsx

Header (from left to right)
1. Subject: subject ID
2. Trial_Num: trial number
3. Fixat_Onset: fixation count
4. Trial_Index: trial ID in milliseconds
5. Fixat_Location: 0=left; 1=right
6. Fixat_Index: fixation ID (the number of fixations within a trial)
9. Fix_Start: start time (in milliseconds) of a fixation in a trial
10. Fix_End: end time (in milliseconds) of a fixation in a trial
11. Fix_Duration: the duration of the fixation in milliseconds (end time minus start time)