Title: The effect of In- vs. out-group influence on social norms compliance

Pre-registration
Nov 14, 2020

Have any data been collected for this study already?

No, no data have been collected for this study yet.

What's the main question being asked or hypothesis being tested in this study? (optional)

People can be easily influenced by others' opinions. However, it remains unclear whether conformity is due to public compliance or private acceptance. Here, we will investigate whether social learning (conformity) will promote public compliance and/or private acceptance.

Furthermore, given group affiliations' important role in social learning, we will investigate how in- vs. out-group opinion will influence social conformity as evidenced by both public compliance and private acceptance.

Previous research has found inconsistent evidence whether the social influence can be long-lasting. Therefore, we will investigate if group affiliation and conformity may have long-term effects by comparing between immediate and 1-week delayed tests.

We plan to examine both behavioral and electrophysiological activities. We clearly distinguish between **social learning processes** and the **aftereffect of social learning**. We aim to unravel how learning processes unfold during social conformity, and the aftereffects of social conformity.

- **Experimental procedure, stimuli and tasks**
    - **Procedure**:
        - There will be two lab visits for each participant.
        - During the first lab visits, subjects will complete the following tasks in order: 1) a pre-learning implicit attractiveness perception task; 2) an explicit rating task; 3) a minimal group paradigm and a group associative training task for group assignment; 4) a social learning task (participants learn about in- and out-group's evaluation of the face attractiveness); 5) a memory task; 6) a post-learning implicit attractiveness perception task; 7) a post-learning explicit rating task. EEG will be recorded during social

learning, the pre-learning and post-learning implicit perception task, and the memory task.
    - During the second (1-week delayed) lab visit, subjects will complete the same memory task, and 2) explicit rating task.

- **Stimuli:** 80 faces are equally divided into 8 condition: a morph faces condition (i.e., prototypical faces that are rated as highly attractiveness); six social learning face conditions in a 2 (ingroup vs. outgroup) by 3 (higher vs. lower vs. consistent ratings) design, with 10 faces in each condition; a baseline condition with 10 faces that are not presented in the learning session (i.e., without any group influence).

- **Tasks**:
    - In both **pre-learning and post-learning implicit perception task**, participants will view all 80 faces in each of six blocks. To maintain participants' attention, they will need to press a button whenever they see an object image presented on the screen. In each block, participants will view 80 unique faces and 24 unique objects. Participants will complete six blocks for this task.
    - In the **social learning task**, participants will view 60 faces from the 6 conditions, with each face repeating for 5 times. Participants will first view their initial rating, followed by group rating. Participants will re-rate the face following group rating to assess the on-line rating changes.
    - In **the post-learning and delayed memory task**, participants will view 80 faces, with 60 faces from the learning session,10 faces from the baseline condition, and 10 faces from the morph faces condition. Participants need to recall 1) whether the face is presented during the learning session; 2) if yes, what is the group rating presented during the learning session.
    - In **the pre-learning, post-learning and delayed explicit rating task**, participants will rate 1) attractiveness of the face; 2) confidence level regarding their rating; 3) perceived warmth and competence of the faces.

- **Specific hypotheses are as followed:**

    - *In- vs. out-group influence on explicit compliance of immediate test?*
        - Hypothesis 1: Subjects will be more likely to comply with in-group norms than out-group norms.

    - *In- vs. out-group influence on private acceptance of immediate test?*
      We have competing hypotheses:

        - Hypothesis 2a: Private acceptance (as evidenced by EEG responses of attractiveness) will only emerge when participants conform to their ingroup members (vs. outgroup members).
        - Hypothesis 2b: There's no difference when participants conform to in- vs. out-group members.

    - *In- vs. out-group influence on explicit compliance of delayed test?*
      We have competing hypothesis
        - Hypothesis 3a: After 1-week, social conformity effect is larger in response to in-group than to out-group influence.
        - Hypothesis 3b: After 1-week, social conformity effect will be no differences between in-group and out-group influences.

    - *Neural processes during social norm learning?*
        - Hypothesis 4: We will focus on feedback-related ERPs during social learning. We hypothesize the conflicting feedback (i.e., the group's rating is higher or lower than their own rating) vs. consistent feedback, ingroup vs. outgroup conditions, will modulate feedback-related ERPs such as FRN, LPC.

Describe the key dependent variable(s) specifying how they will be measured. (optional)

- **Behavioral dependent variables**
    - Individual differences: PANAS, IRI (PT/FS/EC/PD), SDR (SDE/IM), Perceived tightness-looseness of the current society, and SPIN
    - Mean-corrected explicit attractiveness rating of the face from each individual participant during each rating session (pre-learning, overall learning, each block in learning, post-learning and delayed session)
    - Mean-corrected confidence rating of the face from specific subject and rating session (pre-learning, overall learning, each block in learning, post-learning and delayed session)
    - Immediate update in ingroup-higher/ ingroup-lower/ ingroup-consistent/ outgroup-higher/ outgroup-lower/ outgroup-consistent conditions: (mean-corrected 2nd explicit attractiveness/confidence rating) - (mean-corrected 1st attractiveness/confidence rating) for each condition
    - Delayed update in ingroup-higher/ ingroup-lower/ ingroup-consistent/ outgroup-higher/ outgroup-lower/ outgroup-consistent conditions: (mean-corrected 3nd explicit attractiveness/confidence rating) - (mean-corrected 1st attractiveness/confidence rating) for each condition

- Memory error for rating based on memory "hit" items= (recollection of group rating in memory test) - (presented ratings during social learning)

- **EEG dependent variable**
  - For the baseline implicit attractive perception task, we plan to focus on face-sensitive N170, evaluation-sensitive LPC.
  - For the social learning task, we plan to focus on feedback-sensitive FRN, LPC and LPP activities.
  - For the post-learning implicit attractive perception task, in addition to N170 and LPC, we plan to focus on norm-sensitive N400.
  - For the memory task, we plan to focus on retrieval-sensitive LPC.

  - We define the following electrode clusters for ERP analyses:
    - Fronto-central sites (Fz, FCz, F1/2, FC1/2)
    - Central sites (Cz, C1/2)
    - Central-parietal sites (CPz, CP1/2, Pz, P1/2)
    - Left-parietal sites (P3/5, CP3/5,)
    - Right-parietal sites (P4/6, CP4/6)
    - Occipito-temporal sites (left: T7, TP7, P7, PO7; right: T8, TP8, P8, PO8)

  - For implicit attractiveness perception task:
    - ERPs time-locked to the onset of face stimulus (face will be presented for 1500 ms).
    - N170: We will define the N170 time window as from 120 to 220 ms (i.e., 50 ms time window before and after the supposed N170 peak at 170 ms). We will focus on N170 amplitude collapsing across the occipito-temporal sites. Given that N170 may have a right-hemisphere advantage, we will examine bilateral N170 and right-hemisphere N170.
    - LPC: We will define the LPC time window as from 300 to 800 ms. We will focus on LPC amplitude across the central-parietal sites and frontal-central sites.
    - N400: In the post-learning implicit attractiveness perception task, we will additionally measure N400 given its sensitivity to violation of social norms. We will use 300-500 ms as the time window for N400. We will focus on N400 amplitude at the central and central-parietal sites.

  - For the learning task:
    - ERPs time-locked to the onset of feedback of the group's ratings (feedback will be presented for 3,000 ms).

        - FRN: In the current study, we define the time window from 250 to 450 ms. We will focus on FRN amplitudes collapsing across the fronto-central sites.
        - LPC: LPC will be quantified in the same way from 300 to 800 ms. We will focus on LPC amplitude collapsing across the left-, right-, central-parietal sites and frontal-central sites.
        - LPP: In the current study, we define the LPP time window from 1000 to 1600 ms. We will focus on LPP amplitudes collapsing across left-, right- and central-parietal sites and frontal-central sites.

    - For the memory task:
        - ERP time-locked to the onset of the face stimulus (face will be presented for 1000 ms).
        - ERP components will mainly focus on retrieval-sensitive LPC, LPC will be quantified from 300 to 800 ms. We will focus on LPC amplitude collapsing across the left-, right-, central-parietal sites and frontal-central sites.

    - For quantification of ERP amplitudes, we will first find the peak within the corresponding time window; we will then calculate the adaptive mean around the peak. For early ERP components such as N170/FRN, adaptive mean will be based on mean amplitudes of 50 ms time window, using the peak as the midpoint. For later ERP components such as N400/LPC/LPP, adaptive mean will be based on mean amplitudes of 100 ms time window, using the peak as the midpoint. In addition to adaptive mean, we will also measure the mean amplitude for the whole time window for each component.

    - Update of attractiveness perception from pre- to post-learning: we will compare N170, LPC, N400 for each conditions across pre- and post-learning tasks.

How many and which conditions will participants be assigned to? (optional)

The current study adopts 2 (group influence: in- vs. out-group) X 3 (conflict: higher, lower and consistent) within-subject design. All participants will experience all six conditions. Faces stimulus will be assigned to one of these 6 conditions and 1 control condition (i.e., without learning) with counter-balancing across participants.

Specify exactly which analyses you will conduct to examine the main question/hypothesis. (optional)

- **Confirmatory analysis plan**

- Manipulation check
  - One-tailed *t*-tests or their non-parametric equivalent Mann-Whitney U tests (if data violate normality assumption) will be performed on subjective closeness/ group favoritism/ identification of ingroup or outgroup.

- Behavioural data analyses
  - *In- vs. out-group influence on explicit compliance of immediate test?*
    A 2 X 3 repeated measures ANOVA with group (in vs. out-group influence) and conflict (higher, lower and consistent) as IVs on immediate update (attractiveness rating from post-learning minus pre-learning) will be performed. We will further conduct two repeated measures ANOVA with conflict as an IV for ingroup influence condition and in outgroup influence condition, separately.

  - *In- vs. out-group influence on explicit compliance of delayed tests?*
    A 2 X 3 repeated measures ANOVA with group influence (in vs. out-group influence) and conflict (higher, lower and consistent) on delayed update (attractiveness rating from delayed minus pre-learning) will be performed. We will further conduct two repeated measures ANOVA with conflict as an IV for ingroup influence condition and outgroup influence condition, separately.

- EEG analysis
  - Data collection: Continuous EEGs will be recorded based on the International 10–20 system using a 64-channel Waveguard cap (ANT Neuro, Enschede, Netherlands) with an eego amplifier (ANT Neuro, Enschede, Netherlands) at a sampling rate of 500 Hz with CPz as the online reference electrode. The horizontal electro-oculogram (EOG) will be recorded from an electrode placed 1.5 cm to the left external canthus. The impedance of all electrodes will be maintained below 20 kΩ during the recording.

  - EEG Preprocessing: Raw EEG data will be processed offline using EEGLAB toolbox (Delorme and Makeig, 2004) in Matlab. The EEG data will be resampled to 250 Hz digitally, low-pass filtered with a cut-off value of fc = 30 Hz and high-pass filtered with a cut-off value of fc = 0.05 Hz, using the default FIR filter implemented in EEGLAB (order also automatically set by EEGLab). A 50-Hz notch filter will also be applied to remove line-frequency-noise using the default FIR filter implemented in

ERPLab (order = 180). EEG data from EOG, M1 and M2 electrodes will be removed from further analysis. Then EEG data will be re-referenced to the grand average AFTER using the interpolation implemented by EEGLAB to interpolate removed bad channels. After the re-reference, interpolated channels will be removed again, and EEG data will be epoched before being subjected to Independent Component Analysis (ICA). Then eye movement artifacts, distinct muscle artifacts, and other remaining artifacts, will be identified and corrected using a combination of visual inspection of ICA components and the SASICA plugin for EEGLAB (Chaumon et al. 2015) incorporating methods from the ADJUST (Mognon et al. 2011plugin. All trials in which EEG voltages exceed a threshold of +/- 75 μV during the recording epoch will be excluded from further analysis.

- ERP component: Epochs for the implicit attractiveness perception and for post-learning memory task will be set from -200 ms to 1000 ms relative to the onset of the face. The epoch for the learning session will be set from -300 ms to 3000 ms relative to the onset of the feedback of the group's rating. The EEG data will be baseline corrected by subtracting from each sample the average activity of that channel during the baseline period (-200 to 0 ms or -300 to 0 ms).

- *In- vs. out-group influence on private acceptance of immediate test?*
  A 2 X 3 repeated measures ANOVA with group influence (in vs. out-group influence) and conflict (higher, lower and consistent) as IVs on Update of implicit attractiveness perception related ERPs (N170, LPC) will be performed. We will further conduct two repeated measures ANOVA with conflict as an IV for ingroup influence condition and outgroup influence condition, separately.

- *Neural processes during social norms learning?*
  A 2 X 3 repeated measures ANOVA with group influence (in vs. out-group influence) and conflict (higher, lower and consistent) as IVs on ERPs (FRN, LPC, LPP) will be performed. We will further conduct two repeated measures ANOVA with conflict as an IV for ingroup influence condition and outgroup influence condition, separately.

- Behavioural and EEG analysis

        - We will correlate the real-time update of explicit attractiveness ratings with averaged FRN during the social learning.
        - We will correlate the implicit attractiveness perception related ERPs with mean-corrected explicit attractiveness rating in the post-learning session.

- **Exploratory analysis plan**
    - Paired t-test with memory error as DV and group as IV.
    - Paired t-test with memory error as DV and conflict or not (recode higher and lower as conflict condition) as IV.
    - We will examine single-trial FRN and re-rate changes of face attractiveness across each block during the social learning to reveal learning-related changes.
    - We will examine whether changes in attractiveness ratings could also influence perceived warmness and competence ratings.
    - Taking the regression to mean effect into consideration, we will conduct analyses with selected subsets of faces for which participants' ratings were matched across the higher and lower conditions as Zaki et al. (2011) and Huang et al. (2014) suggested.
    - We will test if there's a gender difference.
    - We will correlate the individual differences (IRI, SDR, SPIN) with the update of explicit rating, and update of implicit perception.
    - We will explore the EPN, which has been shown to indicate facial attractiveness in previous research, yet the evidence is not quite consistent. We plan to explore EPNs during the implicit attractiveness perception task (both pre-learning and post-learning). We will also explore EPN and N400s in the post-learning memory task, and EPN changes during the social learning task.
    - In addition to examining univariate a priori defined ERPs (N170, LPC, etc) we will conduct multivariate EEG analyses such as representational similarity analysis (RSA) to investigate representational similarity between morphed faces (i.e., prototypical attractiveness) and faces from each different condition. This indicator could be more sensitive to capture private acceptance of social norms, which is a key hypothesis for our research question.

How many observations will be collected or what will determine sample size? No need to justify the decision, but be precise about exactly how the number will be determined. (optional)

- We decided to collect 42 valid participants to realize planned counter-balancing. This sample size is larger than previous similar studies on face attractiveness ERP and social conformity ERP research (on average *N*=26, Kim et al.,2012; Huang et al., 2014,

Shestakova et al., 2013; Han et al., 2020; Lu et al., 2014; Trujillo et al., 2014; Meng et al., 2020; Zhang & Deng, 2012; Werheid et al., 2007)

- This sample size allows us to detect Cohen's dz = 0.44 based on our within-subject design.

Anything else you would like to pre-register? (e.g., data exclusions, variables collected for exploratory purposes, unusual analyses planned?) (optional)

- **Data exclusions**
  - False response trials in implicit attractiveness perception tasks will be excluded.
  - When participants have fewer than 50% usable EEG epochs (following artifact detection/correction etc.) in EEG sessions.
  - Participants who indicate their own group incorrectly in the manipulation check.
- **Variables collected for exploratory purpose**
  - Mean-corrected explicit confidence rating of the face from specific subject and rating session (pre-learning, post-learning and delayed session)
  - Mean-corrected explicit warmness rating of the face from specific subject and rating session (pre-learning, post-learning and delayed session)
  - Mean-corrected explicit competence rating of the face from specific subject and rating session (pre-learning, post-learning and delayed session)
  - We also collect ratings and perception of a group of morphed faces and control faces (not being influenced in the learning session).
- **Unusual planned analyses**
  - None