

Project

An EEG study of feedback processing in human-to-human and
human-to-machine interactions

Philippe Blache¹, Magali Ochs², Roxane Bertrand¹, Jean-Marie Pergandi^{3,4},
Mireille Besson⁵, and Anne-Sophie Dubarry¹

¹LPL

²LIS

³ISM

⁴CRVM

⁵LNC

***Abstract.** The aim of this project is to develop an experimental environment in which the human subject perceives the behavior of an artificial agent as being natural and engaging. This implies rendering communication with the artificial agent as natural as possible. One important characteristic of a conversation is feedbacks, which implies, that one means of rendering a communication with a virtual agent as natural as possible involves making these feedbacks as natural as possible.*

Publications

M. Ochs (LIS), R. Bertrand (LPL), A. Goujon (LPL), D. Bolger (ILCB, LPL), AS. Dubarry (LPL) & P. Blache (LPL). 2020. *The Brain-IHM Dataset : a New Resource for Studying the Brain Basis of Human-Human and Human-Machine Conversations*. Submitted to the **12th International Conference on Language Resources and Evaluation**. Oral presentation.
[Link to LREC submission.](#)

Last update : November 20 2020.

Fiche Contribution CREx



Brain-IHM

An EEG study of feedback processing in human-to-human and human-to-machine interactions

Investigateurs : P. Blache (LPL), M. Ochs (LIS), R. Bertrand (LPL), JM. Pergandi (ISM, CRVM), M. Besson (LNS) & AS. Dubarry (LPL)

Durée : 1 years (2019-2020)

Contribution

- Preparation of experimental material - videos.
- Preparation of experimental protocol.
- Training of masters student in EEG acquisition.
- Preprocessing of EEG data.
- Analysis and statistical analysis of EEG data : ERP, time-frequency.

Objectif : *The aim of this project is to develop an experimental environment in which the human subject perceives the behavior of an artificial agent as being natural and engaging. This implies rendering communication with the artificial agent as natural as possible. One important characteristic of a conversation is feedbacks, which implies, that one means of rendering a communication with a virtual agent as natural as possible involves making these feedbacks as natural as possible.*

Paradigme - The CREx engineer assisted in the design of the experimental protocol and the preparation of the experimental material, the videos. The paradigm consists of a passive task in which the participants watch and listen to a video of a dialogue between a doctor (always human) and a patient (either human or machine) For further details see annexe A.

Experimental Set-up - As our analysis of electroencephalography (EEG) data will focus on the time interval centered around the onset of the feedbacks, with the T0 positioned at the feedback onsets, it was necessary to define triggers that mark accurately in time the feedback onsets on the continuous EEG data. The experimental protocol included the use photodiodes, which detected the triggers marking the feedback onsets. The photodiodes were adapted so that they could be sent to the Biosemi acquisition system via the ERGO inputs of the Biosemi amplifier (see Annex for details).

Passation - A masters student was trained by the CREx engineer to carry out the EEG experiment using 64-electrode Biosemi system. A total of 40 subjects participated in the experiment. Questionnaires related to each movie were prepared and subjects were asked to fill out the corresponding questionnaire immediately after each movie. The answers to these questions were then transferred to an online document.

Prétraitement - A script to automatically detect the onset of the feedback (verbal and gestural) from the photodiode signals was prepared in Matlab (*PEPS_FBonsets_detect.m*). This script allow permits the feedback type to be distinguished : gestural vs. verbal and congruent vs. incongruent. A script was also prepared to carry out the pre-processing steps on the continuous EEG data. Look to annexe C for details.

All scripts prepared in the in the context of the this study are available in Github via this link : [Github link to Brain-IHM scripts](#).

Analyse –

Diffusion -

Annexe A Preparation of videos

To ensure that the movie types were counter-balanced across subjects, 3 lists each comprising 4 sub-lists (a, b, c, d) were define ; these are summarized in table 2. Each participant was presented the movies in the order defined by a single sub-list, for example subject1 was presented list1a, subject2 list2a and subject3 list3a, then subject4 list2b etc (see table 1).

Version	List1	List2	List3
a	Curare-Human-Cong Perf-Agent-Congruent Reg-Agent-Incong Curare-Human-Incong	Perf-Human-Cong Reg-Agent-Cong Curare-Agent-Incong Reg-Human-Incong	Reg-Human-Cong Curare-Agent-Cong Perf-Agent-Incong Perf-Human-Incong
b	Curare-Human-Cong Reg-Agent-Incong Perf-Agent-Cong Curare-Human-Incong	Perf-Human-Cong Curare-Agent-Incong Reg-Agent-Cong Perf-Human-Incong	Reg-Human-Cong Perf-Agent-Incong Curare-Agent-Cong Reg-Human-Incong
c	Perf-Agent-Cong Curare-Human-Cong Reg-Agent-Incong Curare-Human-Incong	Reg-Agent-Cong Perf-Human-Cong Curare-Agent-Incong Perf-Human-Incong	Curare-Agent-Cong Reg-Human-Cong Perf-Agent-Incong Reg-Human-Incong
d	Reg-Agent-Incong Curare-Human-Cong Perf-Agent-Cong Curare-Human-Incong	Curare-Agent-Incong Perf-Human-Cong Reg-Agent-Cong Perf-Human-Incong	Perf-Agent-Incong Reg-Human-Cong Curare-Agent-Cong Reg-Human-Incong

TABLE 1. The 12 movie orders defined composed of 3 lists and 4 sub-list within each list. These lists were defined to ensure that the order of presentation of the movies would be counter-balanced across participants. Each participant was assigned an individual sub-list.

A single movie file (*.mp4 format) was prepared in which the four movies were presented. A short image with sound was presented before the first movie to test the level of the sound.

Annexe B Experimental Setup :

To ensure that the the feedback stimuli are accurately positioned in the EEG signal, the feedback onsets as perceived in the video data needed to be synchronized with the EEG. We enabled this synchronization, we integrated 2 black squares into each video ; one to mark auditory feedbacks and a second to mark visual feedbacks (both do not have exactly the same onset time). These

black squares changed from black to white such that a specially prepared photodiode positioned against the screen of the monitor could capture the luminosity change. The photodiodes were connected to ERGO1 and ERGO2 inputs of the Biosemi amplifier so that the two photodiode signals would be recorded on two auxiliary EEG channels. To ensure that the different feedback types could be distinguished, the duration of the colour change was varied as a function of feedback modality (auditory, visual) as well as a function of the 4 dialogue types (human-human and human-virtual agent with congruent feedbacks only and human-human and human-virtual agent with congruent and incongruent feedbacks).

Condition	Gestural (Visual)	Verbal (Auditory)
Human-Human (congruent)	200ms	160ms
Human-Human (congruent+incongruent)	400ms	320ms
Human-Machine (congruent)	200ms	160ms
Human-Machine (congruent+incongruent)	400ms	320ms

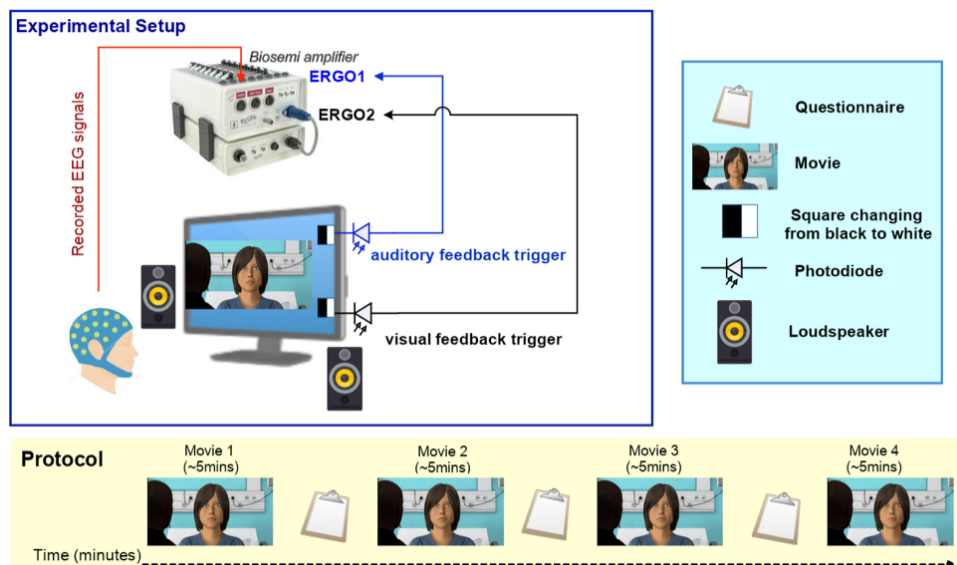


FIGURE 1. A graphical overview of the experimental setup and the protocol.