Analyzing the Direction of Emotional Influence in Nonverbal Dyadic Communication: A Facial-Expression Study

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Research Objective & Method Overview

- Identifying the direction of emotional influence in a dyadic dialogue is of increasing interest in the psychological sciences, e.g., psychotherapy, analysis of political interactions, or interpersonal conflict behavior.

- Facial expressions are perfect measure for a better understanding of unintentional behavior cues about socio-emotional cognitive processes.

- We combine computer vision capabilities along with causal inference theory for quantitative verification of hypotheses on the direction of emotional influence in various instructed interaction conditions using facial expressions.
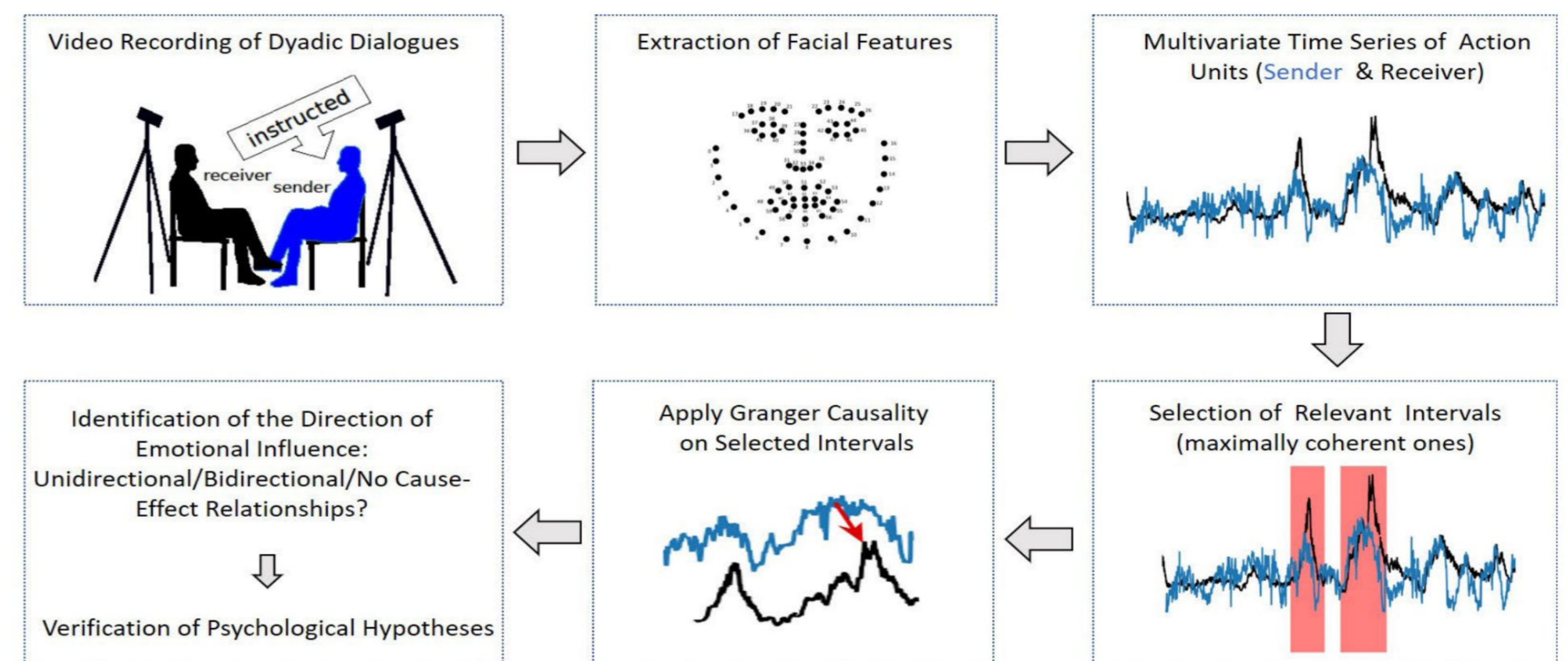

The workflow of the proposed concept for analyzing the direction of emotional influence in dyadic dialogues.

Experimental Setup

- Two participants sat face to face while talking about their personal weaknesses. One participant was in the assigned role of the receiver (R), the other was in the assigned role of the sender (S).
- Two frontal perspective cameras recording at 25 frames per second.
- S was instructed to take on a certain attitude (i.e., respectful, objective, contemptuous), R was unaware of that and acted spontaneously.
- 34 pairs (mean age = 20.72, 24 female pairs, German-speaking participants).
- Three conditions per pair, and four minutes of video per condition.

Extraction of Facial Features

- Facial Action Coding System (FACS, Ekman et al., 1997) breaks down facial expressions into individual components of muscle movement, called Action Units (AUs).
- Any facial expression can be described by a combination of AUs.
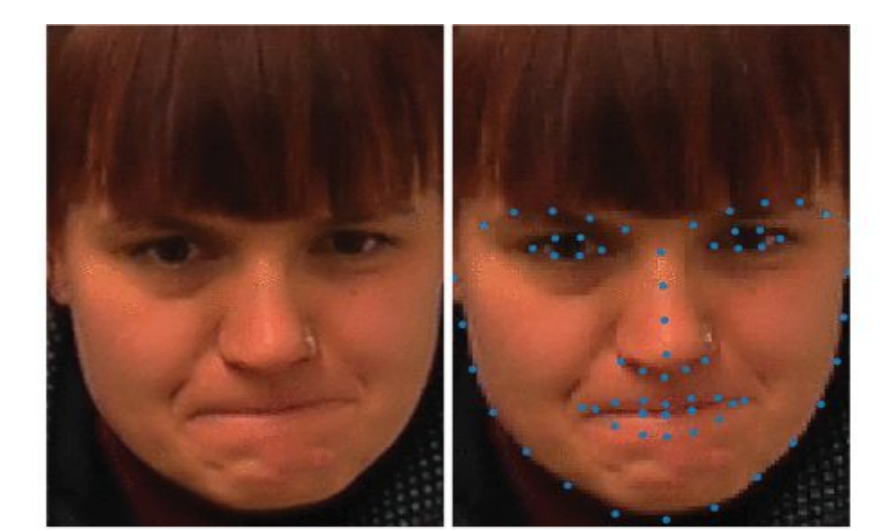
(a) Landmarks of the facial expression;
(b) Detection of AUs using OpenFace for facial expression angry: Strong activation of AU4 (brow lowerer), 7 (lip tightener), 14 (dimpler), and 17 (chin raiser).
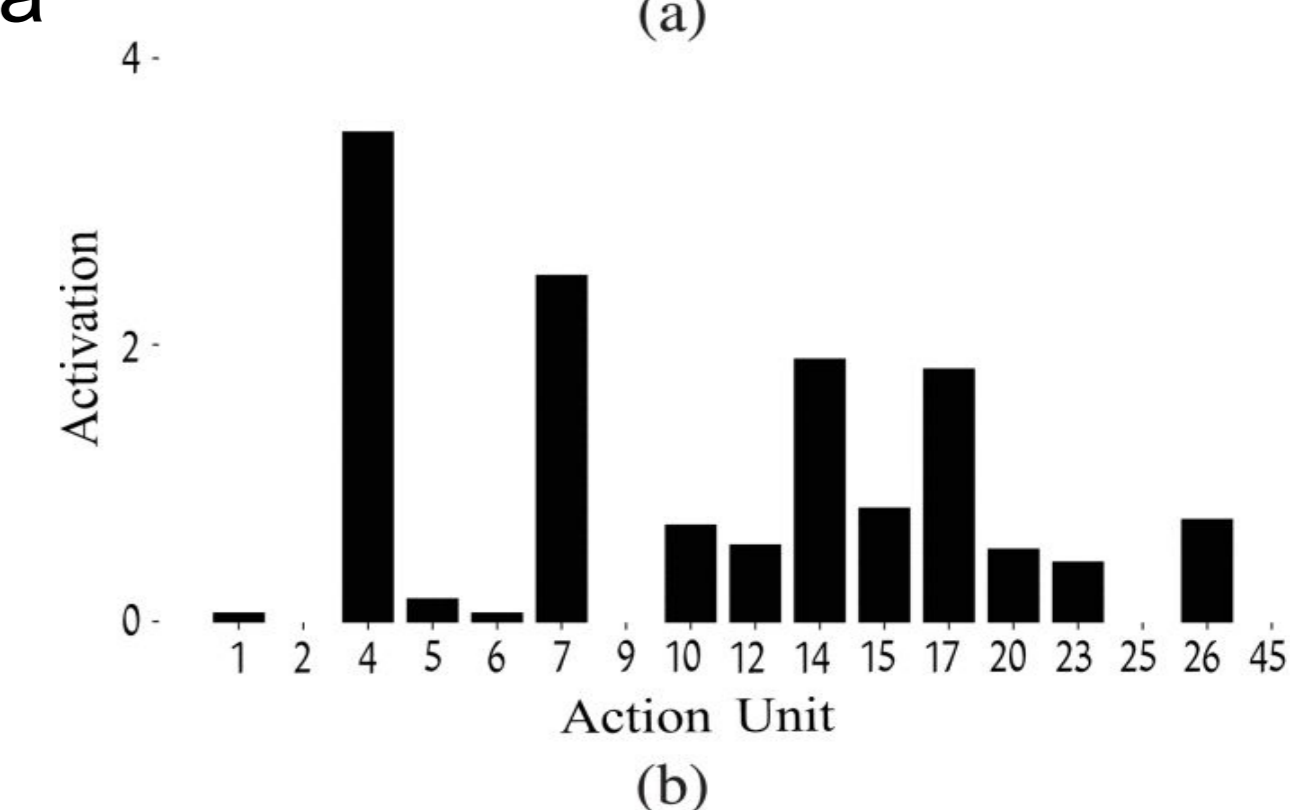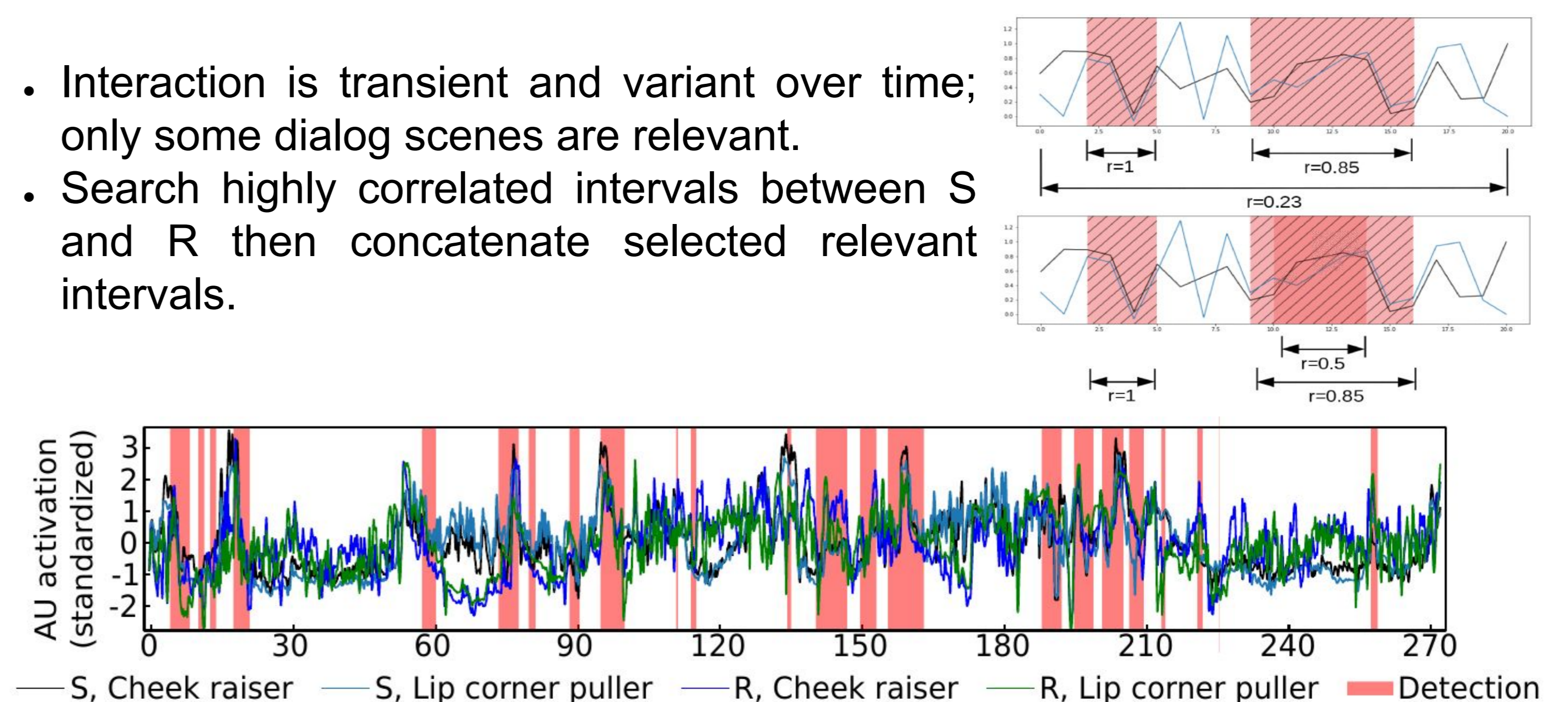
Causal Inference with Granger Causality

Granger Causality (GC): Cause precedes and helps predict the effect.

- Time-series Y Granger causes a time-series X if the inclusion of past observations of Y beside X improves the prediction of X significantly when compared to the prediction using only past values of X.
- To test whether Y Granger causes X, two vector autoregressive models are compared. The first model, in which Y is included for predicting X, and the second one without Y. The residuals of these two models are then compared against each other via a statistical significance test.

Relevant Interval Selection

- Interaction is transient and variant over time; only some dialog scenes are relevant.
- Search highly correlated intervals between S and R then concatenate selected relevant intervals.

Verification of Psycological Hypotheses

Psychological Hypotheses	Experimental Findings
H.1. More harmonic expressions (i.e., happiness) present when both interaction partners are confronted with medium to high levels of respect (i.e., respectful & objective/neutral vs. contemptuous).	✅ Wilcoxon signed-rank test showed significantly higher activation of happiness expressions in the respectful condition compared to the contempt and objective condition.
H.2. The strongest activation of negative expressions (e.g., sadness) presents in the disrespectful condition (i.e., contemptuous vs. respectful & objective/neutral).	✅ Higher activation of sadness expressions in the contempt compared to the objective condition.
H.3. For all emotional facial actions, S causes the effects and influences R.	✅ GC test showed that S influences R particularly in the respectful and objective/neutral compared to the contemptuous condition when using the relevant interval selection approach. ❌ However, in the contemptuous condition, R and S influences each other similarly.
H.4. The strongest GC causality from S to R occurs for positive expressions (i.e., happiness), followed by negative expressions (e.g., sadness).	❌ GC test showed only a slight reduction in the influence from S to R for negative expressions. ✅ However, significantly higher bidirectional influences were observed for positive compared to negative emotions across all experimental conditions. This indicates that positive facial expressions are in general much more "infectious" than negative ones.