Artificial Conversational Agents to Investigate the Neural Bases of Conversation with fMRI

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We present an approach to investigate the neural bases of conversations with fMRI using an artificial agent as control condition. Whole brain activity is recorded with functional Magnetic Resonance Imaging (fMRI) while participants discuss either with a human confederate or a conversational robot. This gives access to local brain responses, including in deep brain structures invisible to other neuroimaging techniques, during the conversation. The present data comprises the recording of 22 participants forming the corpus, and includes, in addition to fMRI data, speech recorded from the participant and interlocutor (human or robot), videos of the interlocutor and eye movements of the participant.

Investigating the neural bases of natural conversations is a timely, but complex, endeavour. It addresses one of the main challenge of social neuroscience today, namely second person neuroscience, in which real(istic) interactions between two people are under scrutiny (Schilbach et al., 2013). Three independent potential methodological difficulties need to be addressed. First, how to get usable data given the constraints of neuroimaging techniques; second, what experimental paradigm is required, in particular what can conversations be compared to ("contrasted with", in neuroimaging jargon); finally, what analysis tools can allow us to make sense of such complex, multidimensional, recordings?

Here we briefly present an experimental approach, described in more details elsewhere (Rauchbauer et al., 2019), designed to solve the three issues. First, functional magnetic resonance imaging (fMRI) is used to record whole brain activity, as it is less prone to artefacts related to muscle movements than electric or magnetic surface recordings. Participants lying supine in the scanner have their head firmly held by foam at the temple level to allow mandible movements necessary for movement. Real-time noise cancelling microphone and in-ear audio stimulation allows conversation despite the loud scanner noise. Second, an experimental paradigm includes a cover-story to hide the real purpose of the experiment, as well as an artificial agent, the conversational robot Furhat (Al Moubayed et al., 2012), used as a control condition. The assumption is that only interactions with a fellow human will lead to the adoption of an intentional stance and hence to natural interactions (Dennett, 1989), while conversation will take place with both agents. Finally, machine learning methods will be developed to investigate causal relationships between the behaviours recorded and time courses of activity in brain areas.

We recorded a total of 25 conversations, 22 being used in the analysis. Preliminary results (Rauchbauer et al., 2019) confirm significant differences between brain activity associated with the nature of the conversational agent, human or robot, possibly associated with social engagement. Current analysis makes use of transcribed conversation to relate brain activity with articulation irrespective of the agent being interacted with, human or robot. Further work will explore the verbal and non verbal aspects of the conversation in relation to brain activity.

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References

Al Moubayed, S., Beskow, J., Skantze, G., & Granström, B. (2012). Furhat: a back-projected human-like robot head for multiparty human- machine interaction. In Cognitive behavioural systems (pp. 114–130). Springer

Dennett, D. C. (1989). *The intentional stance.* MIT press.

Rauchbauer, B., Nazarian, B., Bourhis, M., Ochs, M., Prévot L. & Chaminade, T. (2019) Brain activity during reciprocal social interaction investigated using conversational robots as control condition. *Philosophical Transactions of the Royal Society of London B*. doi: 10.1098/rstb.2015.0615

Schilbach, L., Timmermans, B., Reddy, V., Costall, A., Bente, G., Schlicht, T., & Vogeley, K. (2013). Toward a second-person neuroscience. *Behavioral and Brain Sciences*, 36(04), 393–414.