# Using Social Signal Processing and Conversational Agent To Aid People in their Negotiation Skills

## Self-awareness through Mimicry

by

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TU Delft

# Preface

This thesis contains the experimental- and technical design as well as the results of the conducted study regarding the use of non-verbal mimicry through the medium of a conversational agent to increase a person's self-awareness in negotiation training. I have written this thesis to fulfil the graduation requirements of the Artificial Intelligence Technology track of my Computer Science MSc. degree. The thesis was done at the Interactive Intelligence (II) research group of the faculty EEMCS of the Delft University of Technology and lasted from November 8 2021 to November 8 2023.

This thesis marks the end of my journey of 8 years at TU Delft. If I close my eyes and look back, I can see many new experiences, new friends and fond memories, but also hardships and challenges during my education. Specifically, the master's thesis was particularly difficult. It was during this period that I hit one of the lowest points in my life. However, this process has taught me many things and I would have done it again if given the choice. That being said, I could not have completed my thesis without support from several people.

I would like to thank my supervisor, Catharine Oertel, for her advice and guidance during the last two years. I also would like to thank Laurens Rook and Iulia Lefter for joining the many meetings to brainstorm and provide feedback on this thesis. My gratitude also goes to Catholijn Jonker for providing me the opportunity to write my thesis in paper format for CHI '24. Furthermore, I would like to thank the PhD candidates Masha Tsfasman and Morita Tarvirdians for sharing their office with me and Deborah van Sinttruije for writing and editing our paper submission to CHI '24. Of course, I would like to thank everyone (including the members of the II research group) who participated in this research experiment.

Finally, I would like to show my gratitude towards my father Yat Ming, my mother Bing and my brother Aaron for their continuous support and patience. My final thank you goes to my girlfriend, Yhennifer, for all her love, laughter and motivation.

*Weilun Chen*
*Delft, October 2023*

# Self-awareness through Mimicry: Using Social Signal Processing and Conversational Agent to Aid People in their Negotiation Skills

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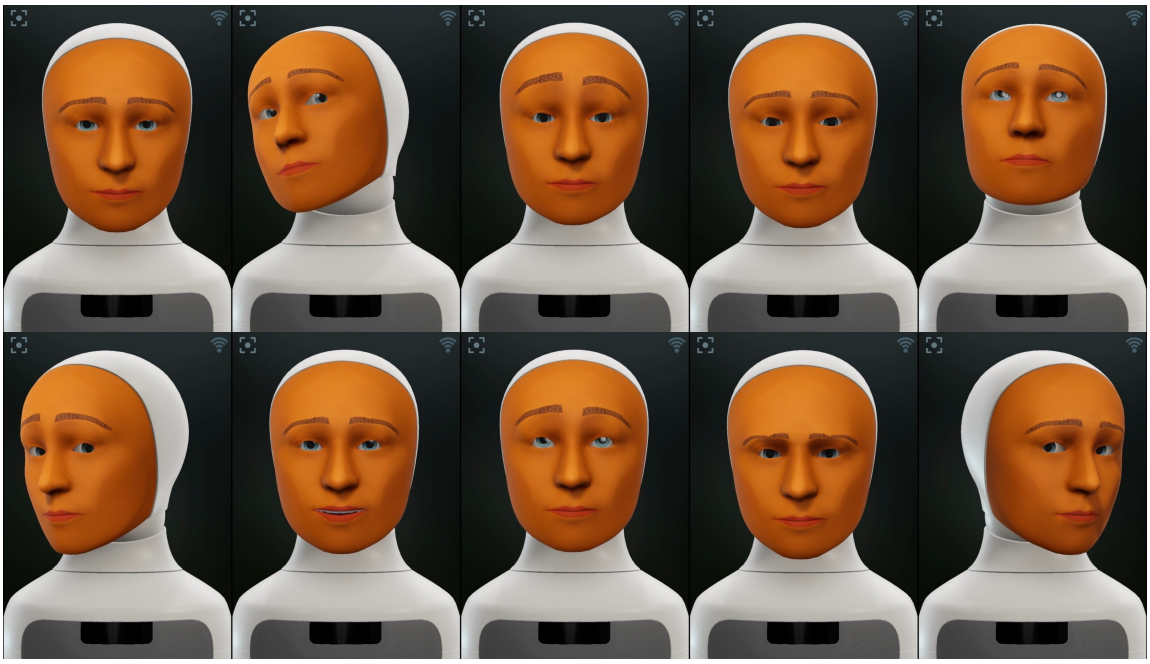


Fig. 1. A mimicking virtual Furhat agent.

Negotiation is not a skill that comes naturally to most people. However, most people could benefit from attaining good negotiation skills. Non-verbal behaviour plays an important role in negotiations. Previous studies have shown a link between mimicry through conversational agents and self-regulation of non-verbal behaviour. The current study aims to raise a person's self-awareness of their non-verbal behaviour through the medium of a conversational agent in negotiation training. An experiment (N = 64) is conducted where participants performed negotiations with an intermediate feedback round where they viewed themselves on a virtual agent. The agent either mimicked the participants' non-verbal behaviour or exhibited idle behaviour. It was found that the mimicking agent provided better feedback to the participants. Furthermore, repeated negotiations increase a person's self-awareness. The data indicate that raising a person's self-awareness in negotiation training by utilising non-verbal mimicry through a conversational agent is feasible.

## 1 INTRODUCTION

Negotiation is not a skill that comes naturally to most people and bad negotiation skills could result in negative economic outcomes [14]. Often it is a skill that is developed implicitly from experience or explicitly in instances such as professional institutions as part of a degree. Negotiation training is more prominently featured in degrees such as business or law than medical or mathematical ones [53]. However, negotiation skills could prove beneficial for every individual. For instance, you discuss a salary raise with your boss or try to negotiate the rent price with your landlord. However, a major part of human negotiations is the social cues of the involved parties. Positive and negative facial expressions might affect the outcome of the ongoing negotiation. A few studies have shown that people are not self-aware of their non-verbal behaviour [9, 32]. This might be accentuated during a heated negotiation. To that extent, it is beneficial to aid people in raising their self-awareness of their non-verbal behaviour which in turn could lead to positive effects in their negotiations. There already exist several systems utilising conversational agents in negotiation training [19, 37, 38]. However, these systems involve text-based feedback [38]. A gap can be identified where conversational agents are utilised in providing non-verbal feedback in negotiation training.

There is an extensive body of literature indicating a relationship between self-awareness and regulation of emotions and thus, to an extent, your non-verbal behaviour. Early work by Duval and Wicklund (1972) and further revised by Wicklund (1975) proposes the self-awareness theory. Their self-awareness theory states that a person is always either focused on the external environment or upon themselves. The latter occurs when a person is reminded of themselves through a medium, such as a mirror or camera. Once a person's attention is upon themselves, discrepancies between their own preferred image and their actual image become bare. These discrepancies had a negative relation between one's preferred image and their actual image. This is further demonstrated by Lanzetta et al. (1982). They found that self-awareness, in the form of a reflecting mirror, had an effect on participants' facial expressions. Specifically, participants were found to be less expressive in their non-verbal behaviour, both positive as well as negative expressions, in the presence of a mirror [47]. Congruently, Silvia's (2002) work found that people with high self-awareness and the belief that emotions should be inhibited expressed less happiness than people with high self-awareness and the belief that emotions should be unregulated [63]. Again, the participant's self-awareness was manipulated by utilising a large mirror. The difference between the two groups was not present when the large mirror was absent. The studies cited above indicate that a third-person perspective of yourself affects your self-awareness and additionally, depending on your beliefs, affects your emotional expressions. Additionally, other research indicates that self-awareness and reflection could be utilised to mitigate the effects of negative emotions during negotiation [3, 51]. Recognizing early signs of anger and fear in yourself and the ways in which you express those emotions would help in dealing with one's own anger. The next step would be to identify the triggers of your anger and fear during negotiations and address them directly. A final step is to be aware of the opponent's emotions and acknowledge them. Empathizing with their emotions could build trust and provide beneficial effects to the negotiation.

There are different types of non-verbal behaviour, e.g. facial expression, gaze, body language and voice levels. Non-verbal cues tend to be more difficult to identify and understand compared to verbal cues. However, they are just as important as verbal greetings or making offers in a negotiation setting. A lot of information can be conveyed in a negotiation interaction without speaking and controlling your non-verbal behaviour could benefit you depending on

your negotiation goals. For example, a dominant negotiation opponent tends to have a longer gazing time [73] as well as possessing a higher visual dominance ratio [20, 25]. A study has shown that dominant non-verbal behaviour, such as expressing anger, results in smaller concession steps taken against the dominant participant in a negotiation setting compared to a participant expressing happiness [70]. In contrast to the previously mentioned study, a different study expressed how dominant non-verbal behaviour could negatively impact the joint gains of a negotiation interaction [2]. On the other hand, the poker face is a much-used tactic in negotiation. Here, the participant is trying to maintain a blank and expressionless facade in order to prevent their opponent from reading their emotions. While this tactic has found success in negotiations [68], it does hinder another tactic in negotiation, namely empathy. It is found that empathy could improve negotiations regarding relationships, such as alliances and coalition building [29]. As mentioned before, an important aspect to consider during negotiation is the participant's own emotions. While some advocate to separate emotions from the negotiation process [27], it is harder said than done. Your own emotions, such as happiness or anger, could not only cloud your judgments during negotiations but also affect your non-verbal facial expressions. Expressions of happiness give an indication of your commitment to the negotiation and opponents. However, expressions of happiness could also be perceived as a weakness. Your opponents could view your positive non-verbal signals, such as smiling, as a sign that they could demand more during the negotiation [7]. Negative emotions, such as anger, could be displayed with downward eyebrow movements. Congruent with expressions of happiness, negative non-verbal signals could make the negotiation process more difficult in various ways [3].

It is not a trivial matter to raise the self-awareness of one's own emotions during a negotiation interaction. A simple and straightforward method would be to show one's own facial expressions. Unfortunately, this might have a negative psychological effect on the individual. The individual might experience the direct and raw footage as too confrontational or uncomfortable. This phenomenon is similar to another phenomenon called voice confrontation [34]. The latter describes when listening to your own voice in an audio or video recording might make you feel uncomfortable. This uneasiness is caused by the fact that you expect a different voice when you are talking than what you actually sound like [33, 75]. Another explanation for the uneasiness that people experience when viewing themselves could also be found with the mere-exposure effect [77]. This effect is a psychological phenomenon where people tend to prefer objects or people that are already more familiar to them. Objects or people that are not or less familiar to them could result in less favourable evaluations. In this case, people find it uncomfortable viewing themselves in a video as their image of themselves is based on what they see daily in a mirror. This mirrored image is slightly different from a video recording as human faces are not entirely symmetrical.

A solution to the discomfort of a video recording could be the integration of conversational agents, where the agent mimics the participant. Mimicry is the act of imitating the characteristics of another person. In this case, the agent would mimic the participant's non-verbal facial expressions. While mimicry is often used for entertainment [54], it does show certain psychological effects to the mimicker and mimicked. For example, it has been found that the mimicked tend to take a bigger liking to the mimicker than a non-mimicker in various settings [18, 52]. This liking is further extended in rapport and affiliation with the mimicker. Furthermore, conversational agents have proven to have positive effects in various fields of entertainment, commerce [61] and the educational system [71]. The latter can range from learning simple mathematical equations [42] to more complex linguistics [56]. Another promising field of learning with virtual agents is negotiation training [30, 57]. However, there is not much done on the use of mimicry performed by conversational agents in a negotiation training setting. To that extent, this paper focuses on raising the self-awareness of people by utilising conversational agents and mimicry of their own non-verbal facial expressions to improve their negotiation skills. Specifically, this paper aims to answer the following research question:

(1) Is the use of non-verbal mimicry through the medium of a conversational agent a viable method to increase the self-awareness of a person in negotiation training?

Studies have shown that mimicry has beneficial effects for the mimicker in human-human interaction [18, 52]. Furthermore, it was also found that personalized feedback provides better reflection to participants in negotiation training [37, 38]. However, it has not been explored whether non-verbal mimicry in a conversational agent as negotiation feedback would increase the self-awareness of a person in negotiation training. We hypothesise that:

(1) **H1**: a conversational agent, which exhibits non-verbal mimicry, provides better feedback than a non-mimicking conversational agent
(2) **H2**: the self-awareness of a person is increased after receiving feedback from a mimicking conversational agent in negotiation training

In this paper, we will highlight key aspects of the research as well as the development of the mimicry pipeline for a conversational agent in 4 sections: 1) Related work, 2) Method, 3) Results and 4) Discussion. In 1) we will dive into the related work and state-of-the-art negotiation training with conversational agents and non-verbal feedback. In 2) we will elaborate on the used technologies and the pipeline for the mimicry generation. In parallel, we will also define the 2x2 factorial design experiment and its evaluation process. After the method section, we will present the results obtained from the experiment in 3). Finally, in 4) we will discuss the results and recommendations for future work.

## 2 RELATED WORK

### 2.1 Raising self-awareness with (embodied) conversational agents in human-agent interaction

Traditionally, conversational agents are text-based dialogue systems that provide users with a conversation-like experience with an agent [74]. However, text-based agents lack the communication that non-verbal behaviour contributes to an interaction. Embodied conversational agents aim to alleviate this challenge by having a virtual visual representation of the agent [17]. Conversational agents as well as embodied conversational agents are deployed in various fields, including e-health [4, 15, 36], commerce [61, 65] and education [42, 56, 71], in order to aid people.

There exist several systems aiming to raise the self-awareness of people. A recent study by Hopman et al. (2023), explored the use of an embodied conversational agent as a digital coach in order to encourage self-reflection and empower users with cognitive emotion regulation strategies. The authors reported that their system provided a successful emotion regulation intervention to their participants [35]. However, they primarily focused on the design of the agent's dialogue. And while they utilised an embodied agent, they did not focus on developing non-verbal facial behaviour. Similarly, a study performed by Tanaka et al. (2017) investigated the use of an embodied conversational agent for social skills training in people with autism spectrum disorders. The agent expressed minimal non-verbal behaviour during training, but the proposed system provided text-based feedback regarding the smiling ratio and the head pose to the participants. Additionally, the feedback was accompanied by video fragments of the participants during the training. While Tanaka et al. incorporated the non-verbal behaviour of the participants into the training, the system did not utilise the conversational agent in providing feedback to the participants. The authors did report significant improvement in social skills between pre- and post-training [66]. Raising the self-awareness of participants' non-verbal behaviour by utilising an embodied conversational agent that relays the feedback is a topic that has not been explored to the best of our knowledge. To that extent, a mimicking conversational agent plays an active role.

## 2.2 Mimicry

Mimicry is more prevalent around us than one might think. Early studies in psychology have shown that people tend to mimic each other's verbal [16, 28, 72] as well as non-verbal expressions [11, 45] in social gatherings. This mimicry tends to be performed subconsciously. Furthermore, there are studies that indicate that mimicry results in higher positive evaluation of the mimicker by the mimicked [18, 46, 52]. This increased liking is also found applicable to conversational agents. In an early study, it was found that a virtual agent who mimicked the participants' head movements received more positive ratings than a non-mimicking agent [5]. The authors utilised an aggregated score for the agent's effectiveness based on the persuasiveness, impression and social presence of the agent. Additionally, the participants found that the mimicking agent was more persuasive than its non-mimicking counterpart. More recent studies are congruent with earlier works involving mimicry and conversational agents. For example, Aburumman et al. (2022) found that integrating head nod mimicry in virtual reality agents resulted in more likeable and approachable agents [1]. Similarly, this also has been found for torso movements [31]. Furthermore, a study conducted by Park et al. (2021) found that participants rated agents that embodied their habitual facial expressions higher than agents that did not. More strongly, participants felt more similar and familiar with the mimicking agent [58].

The studies cited above indicate that a mimicking virtual agent is more positively received by participants. While the studies utilised measures that differ from providing negotiation feedback, it could indicate that a mimicking conversational is more suitable in providing negotiation feedback than a non-mimicking agent. However, this has to be investigated.

*2.2.1 Mimicry for self-awareness.* Mimicry has been shown to have some effect on social interactions as well as negotiations as described in section 2.2 and section 2.2.2. However, is there a connection between mimicry and self-awareness or reflection? Some studies have found a link between mimicry, self-regulation and social coordination. An increased capacity of self-regulation could result in greater self-control and therefore a greater focus and ability to achieve one's own goal [50]. For instance, Barmaki and Hughes (2015) conducted a study where student teachers received real-time non-verbal feedback on their body postures. It was found that participants who received the feedback were significantly more self-aware of their body posture and performed better in utilising open postures. Furthermore, Qu et al. (2017) investigated the individuals' self-awareness of their own facial expressions in two modalities, i.e. in real-time and in a video review. Here, participants were shown a series of short video stimuli and were tasked to state whenever they became aware of their own facial movements. After a short intermission, the participants were tasked to review their own facial expressions on video and identify any facial movements. It was found that participants were more self-aware in their video reviews compared to real-time [59]. Congruent with the studies [47, 63, 76] discussed in section 1, this indicates that a third-person perspective of yourself affects your self-awareness of a particular behaviour.

*2.2.2 Mimicry in Negotiation.* The increased likeability and persuasiveness of mimicking, as mentioned in section 2.2 has its benefits in the context of negotiations. It was found that mimicking the opposing party during a negotiation improves the negotiation outcome. More strongly, it was found that the mimicker secured an increased individual gain compared to their opponents [49]. Furthermore, the authors found in a secondary study that mimicking negotiators have a higher likelihood of securing an agreement where a prima facie solution was not possible. The increased persuasiveness is extended for virtual agents.

Roth et al. (2018) investigated the effects of non-verbal mimicry during a negotiation interaction [62]. In particular, the authors proposed a naive approach that focuses on the mimicry of the upper body in a virtual reality (VR) environment.

The purpose of the mimicry was to enhance the affiliation, rapport and liking of the mimicker. The mimicked was shown to enhance liking, rapport and empathy. More importantly, the authors investigated the effect of injected mimicry into a real-time negotiation interaction. To that extent, the study consisted of participants' virtual embodiment showing either 1) only the original behaviour or 2) the original behaviour plus injected mimicry. The authors used objective measures, e.g. interaction time and negotiation outcome, as well as subjective measures, e.g. self-reported co-presence, rapport and trust to evaluate the study. Their results show that there was no direct impact of the mimicry on the perception of the participants during the negotiation interaction. However, some of the participants were able to detect the injected mimicry.

### 2.3 Negotiation Training with Autonomous Agents

While the use of mimicry in negotiation training has not been thoroughly investigated, there is existing literature available on negotiating training with autonomous agents. It is important to consider the use of virtual agents in negotiation training. Specifically, how virtual agents are utilised in the context of providing feedback and raising the participant's self-awareness. An early work on negotiation training with an embodied virtual agent is conducted by Core et al. (2006) [19]. The authors distinguished themselves from earlier work by endowing the virtual agent with human-like negotiation behaviour. In order to accomplish that, the authors aimed to model emotions that could arise during the negotiation process. The participants received text-based feedback on their negotiation interaction in an intermediate round where they had to manually select predetermined points of interest during the negotiation. During the feedback round, the participants reflected on their given responses during the negotiation dialogue by selecting alternative responses. In later studies Johnson et al. (2017) and Johnson et al. (2019) put more emphasis on the feedback round between the negotiation rounds in their experiments. The former provided negotiation training feedback in the form of an automated generated report based on the negotiation principles of Kelley (1996) [41]. The former only explored the possibility of providing feedback with an automated system. The latter study conducted a more extensive study on providing an automated feedback report. Specifically, the feedback report was personalized to the participant in order to determine whether participants who received personalized feedback performed better than participants without [38]. The study distinguished three groups: (1) Personalized feedback, (2) Generic feedback and (3) No feedback. It was found that participants who received personalized feedback scored the highest points in the negotiation training. Congruent with the former study, the participants were given text-based feedback during the feedback phase. The use of an embodied conversational agent as a medium for negotiation training was not explored. However, it can be observed that negotiation feedback that is personalized to the participant is beneficial in negotiation training. Furthermore, the discussed work provides a clear framework for negotiation training. Negotiation training should consist of a minimum of two negotiation rounds with an intermediate feedback round. This framework is further supported by the experimental learning theory [43]. This theory states that learning is more than just the learning outcome, it should rather be viewed as a whole process. Kolb and Kolb (2012) found that reflection for participants on their subsequent actions plays a major role in the learning process. There exists literature that deviates from the above-mentioned negotiation training framework. One could provide feedback in real-time to the participants, i.e. during an active negotiation interaction, as [64]. The real-time approach bares resembles to the studies regarding self-awareness and regulation of emotions [47, 63, 76], as described in section 1. However, real-time feedback interferes with the learning process stated by the experiential learning theory [43]. Participants should have a dedicated phase where they can reflect on their past actions.

### 2.4 Non-verbal behaviour

The goal of this paper is not focused on designing the perfect mimicking agent, but on the utilisation of a mimicking agent in order to assess its effect on self-awareness in a negotiation setting. However, it is not trivial to determine what non-verbal behaviour should be included in the agent's mimicry of the participant. Furthermore, modelling human-like non-verbal feedback is rather difficult for conversational agents. Despite the difficulty, work has been done in order to mimic human-like behaviour. While it started from rule-based approaches, generative models have gained traction in recent years. For example, Jonell et al. (2019) took a deep learning approach to generate facial expressions and head movements. It was found that having little facial expressions and head movements was significantly better than having no facial expressions and head movements at all [39]. Tsfasman et al. (2021) focused on head pose, smile and mouth movements in their study on perception of anthropomorphism in human-agent interaction [69]. Additionally, Kucherenko et al. (2020) proposed a framework for gesture generation that utilises both speech acoustic and semantic features [44].

The studies cited in this section predominately involved non-verbal behaviour in the form of facial expressions and head movements, e.g. [1, 37–39, 58, 59, 69]. While studies involving other non-verbal behaviours, such as body posture, have shown some effect on the participant's self-awareness [8], the emphasis of the current study has to be put on facial expressions. This is further extenuated by the discussed studies involving the participants' self-awareness through (real-time) feedback [47, 59, 63]. Furthermore, the use-case of negotiation training motivates the choice of non-verbal facial expressions. Non-verbal behaviour in the form of facial expressions and head position has an effect on the negotiation interaction as described in section 1.

## 3 METHODOLOGY


Fig. 2. The proposed mimicry pipeline

### 3.1 The Proposed Pipeline

The goal of the current study is to investigate whether mimicry through a conversational agent is a viable method to raise the self-awareness of participants in a negotiation setting. Specifically, this paper proposes an embodied virtual agent that will mimic a participant's own non-verbal facial expressions during a feedback round between human-human negotiation rounds in order to further the participant's self-awareness. The playback video will provide a third-party perspective to the participants in order to become more self-aware of their facial expressions [8, 47, 63, 76]. The conducted study is further elaborated in section 3.6.1. The mimicry is constructed in several states as shown in fig. 2.

Tsfasman et al. utilized the virtual Furhat agent, which mimicked the researcher, in their study. The mimicry was limited to the head pose and mouth movements of the researcher. We extended the existing mimicry pipeline with eye gaze and eyebrow movements. The overall system is implemented in Python 3.7.9.

| Non-verbal Behaviour | Openface Features | Furhat Gestures |
|---|---|---|
| Head pose | pose_R(x, y, z) | NECK_(PAN, TILT, ROLL) |
| Mouth movement | AU (6, 12, 25) | SMILE_OPEN<br>PHONE_BIGAAH |
| Eyebrow movement | AU (1, 2, 4, 9) | BROW_UP_(LEFT, RIGHT)<br>BROW_DOWN_(LEFT, RIGHT) |
| Eye gaze | gaze_angle_(x, y) | GAZE_(PAN, TILT) |

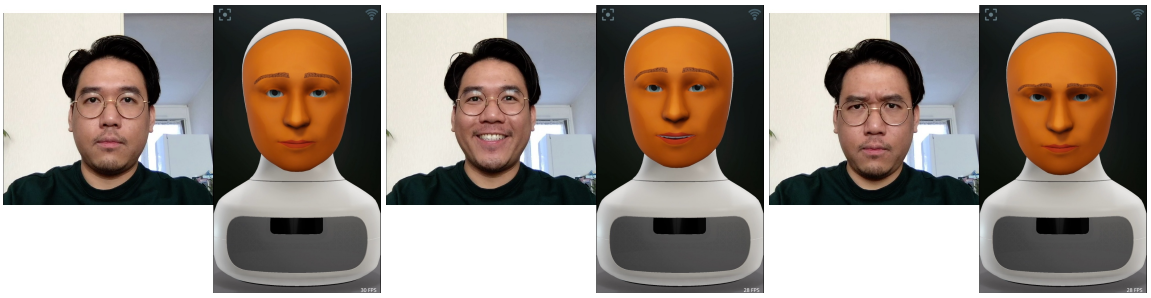
Table 1. Each non-verbal behaviour that is mimicked by the agent with its corresponding extracted OpenFace features and utilised Furhat gestures.

### 3.2 Facial Feature Extraction, Feature Manipulation & Translation

A human's face consists of numerous muscles in order to express themselves non-verbally. Ekman and Friesen (1978) defined a comprehensive system of a person's facial muscles and their activation during a facial expression. Their Facial Action Coding System [24] (FACS) consists of facial Action Units (AUs). Each facial AU represents a particular motion of muscle or a group of muscles. For example, AU-45 is defined by a person blinking and AU-12 is defined by a person pulling up their lip corners. The latter is often observed when a person is smiling [40].

The mimicry pipeline starts with the extraction of the facial features of the participants. We utilised OpenFace [6] for facial landmarks, AU detection as well as head pose and eye gaze tracking. The extracted facial features are manipulated and translated prior to being shown on the desired platform: the Furhat Robot (section 3.3). Participants are shown either their actual facial features or an idle behavioural state of the Furhat Robot, as illustrated in fig. 2. In the case of the former, the extracted non-verbal facial features from Openface are translated into basic Furhat gestures. Specifically, head pose, mouth movement, eyebrow movement and eye gaze are processed. Table 1 depicts the extracted facial features used for each processed non-verbal behaviour as well as its corresponding Furhat gesture. Figure 3 illustrates examples of the mimicry pipeline's output next to the user's baseline.

The following sections describe the implementation of each non-verbal facial behaviour in more depth. First, it explains the chosen facial features. Secondly, it explains how these chosen features are translated into Furhat gestures.



(a) Baseline (b) Happy Expression (c) Angry Expression

Fig. 3. Examples of the mimicking agent based on the user's non-verbal behaviour next to its baseline.

*3.2.1 Head Pose.* It is important to consider a person's head position as looking down or up could provide useful information on the person's dominance during negotiations. Therefore, the features as described in table 1 are considered for a person's head pose. The rotation parameters describe the rotation of the head, with respect to the camera, in terms of pitch, yaw and roll. Furthermore, these values range typically from minus 1 to 1. Furhat offers corresponding gestures in neck pan, tilt and roll. Specifically, neck pan controls the horizontal head movement, neck tilt controls the vertical head movement and neck roll allows the Furhat agent to make rolling neck motions. These Furhat gestures have a range of minus 50 to 50. Therefore, the strength of the resulting gesture is determined by the extracted value multiplied by a scalar value of 50.

*3.2.2 Mouth Movement.* Facial AU 6 and 12 define a cheek raiser and lip corner puller respectively. These two AUs give a good indication of a smile on a person's face. The intensity of the two AUs is extracted from OpenFace and ranges from 0 to 5. Furthermore, the extracted values are multiplied with a scalar value of 0.2, as the strength of Furhat gestures ranges from 0 to 1. Additionally, AU 25 is extracted and defines an open-mouth gesture. The addition of AU 25 is needed, as the combination of cheek raiser and lip corner puller does not consistently indicate a smile. In order to distinguish between a smile and an open-mouth gesture, a happiness strength is introduced. The happiness strength is defined by the scaled cumulative value of AU 6 and 12. Then, if the happiness strength is higher than a certain happiness threshold, a smile is generated. Otherwise, a regular open-mouth gesture is generated when AU 25 is above a certain open-mouth threshold. It was found that a happiness threshold and an open mouth threshold of 0.4 give adequate results.

*3.2.3 Eyebrow Movement.* Basic eyebrow movements can be categorized into upward and downward movements. The position of a person's eyebrow can convey certain emotions in combination with other facial muscles. For example, an upward eyebrow movement (AU 1) combined with an open mouth gesture (AU 25) could indicate that a person is surprised, whereas a downward eyebrow movement combined with tightened lips could indicate that a person is angry [21]. The inclusion of eyebrow movements in the agent should provide a better mimicry of a person's expressed emotions. Facial AU 1, 2, 4 and 9 are extracted for the eyebrow movements, as seen in table 1. The former two define an upward movement and the latter two a downward movement. Congruent with other AUs obtained from Openface, the extracted values range from 0 to 5. Furthermore, Openface considers an AU as activated when the value is greater than 1.0. Therefore, we generate an eyebrow gesture when either AU 1 or 2 and AU 4 or 9 are above said threshold. Furhat offers manipulation of each eyebrow individually and, congruent with its mouth movement gestures, has a strength between 0 and 1. We determine the strength of an eyebrow gesture by the average of the extracted values, i.e. AU 1 and 2 or AU 4 and 9, multiplied by a scalar value of 0.2.

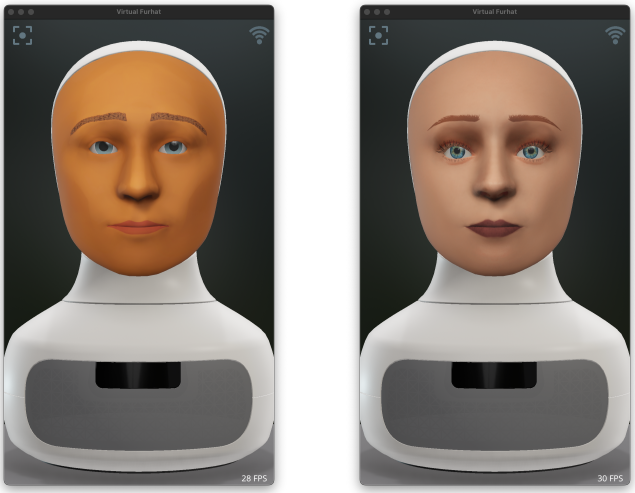
*3.2.4 Eye Gaze.* OpenFace provides eye gaze vectors that indicate in which direction a person is gazing, see table 1. *Gaze angle x* should range from positive to negative in the case that a person is looking left to right. Congruently, *gaze angle y* ranges from positive to negative when a person is looking downwards to upwards. However, it was found that this was not consistently the case during development. Therefore, a short calibration video is taken at the beginning of the experiment in order to calibrate a participant's eye movements. Participants are asked to gaze in eight different corners of their field of vision. Then, we extract the maxima and minima of their gaze features from the calibration video. Additionally, their neutral gaze is extracted for eye gaze mimicking as well as evaluation purposes. A neutral eye gaze indicates that a participant is gazing upon their opponent as participants are seated across each other, see fig. 8.

Furhat offers eye gaze control in the form of two gestures. Congruent to the head movement gestures, *gaze pan* controls horizontal eye movements and *gaze tilt* controls vertical eye movements. Then, the participant's eye gaze

features are normalized by relating them to the established maxima, minima and neutral positions. Subsequently, these values are mapped to the corresponding Furhat gestures by using a scaling function adapting to the range of minus 50 to 50. For example, when a participant is gazing at their maximum right, the Furhat agent will do the same.

### 3.3 Video Generation

The last stage of the mimicry pipeline requires an avatar to show the participants their non-verbal expressions. As alluded to in section 3.2, the desired avatar is the Furhat Robot[1]. The choice for Furhat is taken as this platform puts an emphasis on facial expressions. Furhat offers many built-in facial gestures for detailed control of facial expressions and eye gaze movement. For example, smiling, looking up/down and lifting (individual) eyebrows. Furthermore, the virtual Furhat environment gives us the choice of a male and female face during the study. Figure 4 illustrates the utilised faces.




(a) Default Face (b) Isabel Face

Fig. 4. The virtual Furhat Robot

Furhat offers a Remote API for its various controls. The mimicry pipeline makes requests via Python to the API endpoints in the last stage of the pipeline. We primarily utilised the endpoints */furhat/gesture* and */furhat/say* for performing gestures and playing the participants' natural voices, respectively.

*3.3.1 Voice.* The virtual Furhat robot plays the audio of the negotiation interaction. We decided to not synthesise the participants' voices and utilise the natural voices of the participants. While Automated Speech Recognition, ASR, has made great strides in the past years [55]. It still shows shortcomings, as errors in punctuation could lead to incorrect and misleading sentences. Furthermore, speech recognition and synthesis are out of the scope, given the focus of our study.

An audio file is directly extracted from the recorded video footage. This is done by using the open-source software FFmpeg. Simultaneously, the audio file is converted into a wave (.wav) file with an audio bitrate of 16 bit, a sample rate of 16kHz and a mono channel for compatibility with the Furhat agent. Furthermore, the Furhat robot remote API could

[1] https://furhatrobotics.com/

solely play audio files retrieved from a URL or its Skill resource folder. Therefore, a virtual server was set up for the Furhat robot to retrieve the wave files. There are various ways to set up a virtual server. However, a localhost Python server was chosen in order to keep consistent with the overall code base.

### 3.4 Use-Case Scenario

The predetermined negotiation topics are derived from the Harvard School of Law's Program on Negotiation (PON). This program contains an extensive list of negotiation scenarios for role-play purposes. *Aerospace Investment* and *Bullard Houses* are the two predetermined topics selected for the first and second negotiation rounds of this experiment, respectively. These topics were chosen as the main story for each scenario as they could be relatable to contemporary people. However, the scenarios, definitions and duration of the negotiation are significantly reduced in order to make the topics more digestible as well as reduce the total time of the experiment. Both participants are given an information sheet regarding the negotiation topics prior to the negotiations. This information sheet contains a small summary of the topic as well as the stances and goals of each party during the negotiation interaction. The information sheets can be found in appendix A.

The structure of both negotiation topics is similar. Participants are asked to negotiate on two variables in each negotiation round. Often this variable is the price for a certain good or a percentage of equity in a company. The participants are only shown the stances and goals of their own party. They are unaware of the goals of the opponent. Furthermore, the negotiations are started by an initial offer from one of the participants. Figure 5 illustrates the *Aerospace Investment* scenario as an example and table 2 depicts a corresponding sample negotiation dialog. The initial offers in both negotiations are consistent throughout all the groups. This is done in order to create a baseline from which we could analyse where each pair ends up in the negotiations. It is possible that the participants do not reach an agreement in the negotiations given the time limit of 5 minutes per negotiation round. While this is not trivial, it is not entirely important as well, as we prioritize focus on non-verbal facial expressions over the negotiation outcomes. However, the negotiation outcomes do provide a richer analysis of the results in section 4.

### 3.5 Pilot Study

*3.5.1 Experimental Design.* A pilot study was conducted prior to the current study in order to determine whether the mimicry pipeline was adequate in its mimicry of the participants. Furthermore, the pilot study tested the overall experimental flow including the use-case scenarios. Contrary to the use-case scenario, the negotiations in the pilot involve a participant and the researcher. Furthermore, the agent will playback the participants' natural voices captured earlier in the negotiation round.

*3.5.2 Participants.* A total of seven participants, consisting of four males, and three females, participated in the pilot study. The participants' ages ranged between 23 - 29 years old (M = 27.286; SD = 2.050) and most of them possessed a relevant background in Computer Science. Furthermore, participants were recruited from the campus of Delft University of Technology.

All experiments were approved by the Human Research Ethics Committee of the EWI faculty at Delft University of Technology. Additionally, all participants approved participation by a signed informed consent form.

*3.5.3 Experimental Procedure.* Each participant was led into a room where the researcher instructed him/her on where and how to sit in front of the camera. Figure 8 illustrates the room setup, however, the researcher replaces one of the participants. When the participant is situated, the researcher will start by making a short calibration video as described

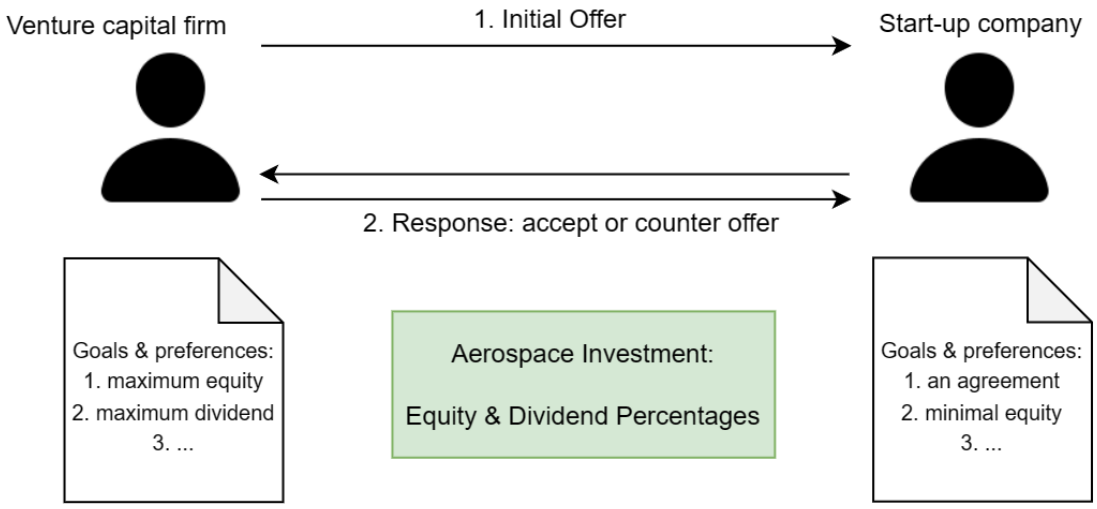



Fig. 5. The Aerospace Investment scenario involves a venture capital firm and a start-up company. Each party has its own goals. The two negotiation variables are the equity of the start-up company and the to be paid up dividends.

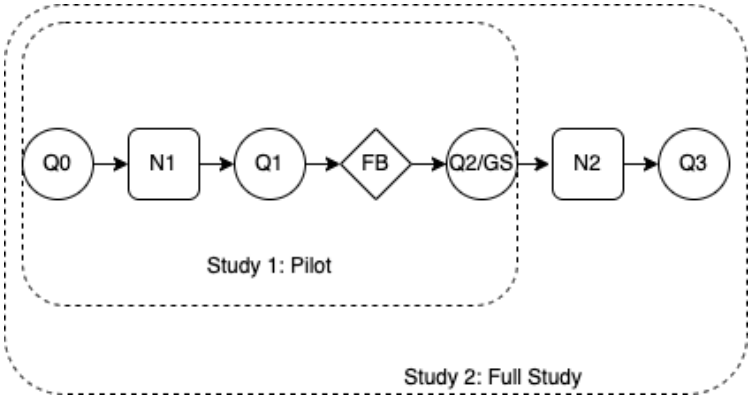



Fig. 6. Comparison of study and the pilot; **Qx**: Questionnaire x, **Nx**: Negotiation x, **FB**: Feedback Video

in section 3.2. The researcher proceeds by briefly explaining the Aerospace Investment scenario. The participant is allowed to ask any questions regarding the scenario. Then, the researcher records the negotiation round between the participant and himself. The negotiation round lasts roughly five minutes or less if both parties come to an agreement. Afterwards, during the feedback round, the participant views their feedback video, where their non-verbal behaviour is mimicked by the Furhat agent. Additionally, the participant views the researcher's feedback video as well. It is important to note, that the researcher does not explicitly state to the participant that he/she is viewing their non-verbal behaviour, only that they are viewing themselves. Throughout the whole pilot experiment, the participant is asked to fill in questionnaires at various stages, i.e. (0) pre-test, (1) after the negotiation and (2) after the feedback round. Figure 7 illustrates the experimental flow of the pilot study.

| | |
|---|---|
| **V** | Hello. |
| **S** | Good day. |
| **V** | I'm happy that you are willing to discuss our investments in your company. |
| **S** | Yes, I'm more than happy to discuss possible terms for our future collaboration. |
| **V** | I see that the other terms are agreed upon, however, there is still the issue regarding the equity percentage as well as the dividends. I would suggest an equity stake of 40% and a dividend percentage of 15%. |
| **S** | An equity of 40% is quite high. Would you be comfortable with 30%? |
| **V** | Our venture capital firm wants a minimum equity stake of 40%, so I can't go lower than that. However, we could lower the dividend percentage a bit. |
| **S** | That is understandable. Then, if we offer 40% equity, would you be able to lower the dividend percentage to 10%? |
| **V** | A lower dividend percentage is acceptable. Could we meet mid-way and do 12.5%? |
| **S** | I believe that an equity stake of 40% is already quite substantial. Thus. We will not be able to do 12.5%. However, we truly want to collaborate with your company. We hope that the dividend percentage could remain at 10%. |
| **V** | I understand that the equity stake is substantial and our company does want to cooperate with your start-up. Thus, we are willing to lower the dividend percentage to 10%. |
| **S** | Great! Thus, we agree on an equity stake of 40% and a dividend percentage of 10%. |
| **V** | Yes, I don't that we could improve the current package. |
| **S** | I agree. Thus, we could conclude our negotiation. Thank you for your cooperation. |
| **V** | Likewise. The paperwork will be sent shortly. |
| **S** | Thank you and goodbye. |
| **V** | Goodbye. |

Table 2. An example negotiation between the venture capital firm (**V**) and the start-up company (**S**) of the Aerospace Investment scenario.

*3.5.4 Measures.* In order to determine whether the mimicry pipeline is adequate, several questionnaires are filled in by the participants. The participants give their subjective rating regarding various questions, including recognition of themselves and their opponents in the feedback video, on a 7-point Likert scale. For example, the participants are asked to rate their self-awareness from "very un-self-aware" to "very self-aware". Furthermore, several questions regarding self-awareness of non-verbal facial expressions and expressed emotions are included in the questionnaires in order to investigate what effect the feedback video has on the self-awareness of the participants. A small within-subjects analysis with time as the independent variable and self-awareness as the dependent variable is included. The results of the pilot study can be found in section 4.1.

*3.5.5 Discussion.* A trend can be observed based on the self-reported measures regarding recognition in table 3 and fig. 10. Participants were better able to recognize themselves in the feedback video compared to their opponents in their

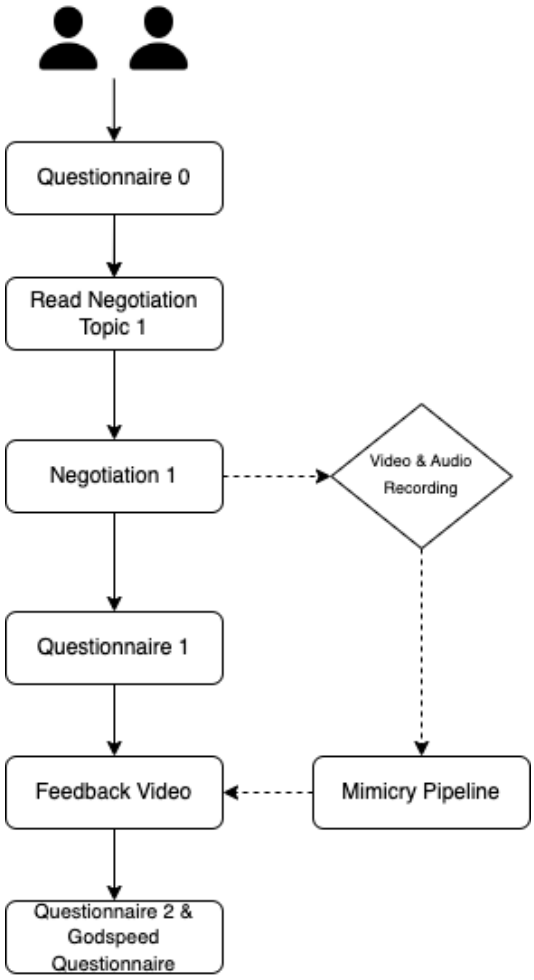



Fig. 7. Experimental Flow of the pilot study.

respective feedback videos. This notion extends to overall recognition as well as recognition of non-verbal expressions. This trend could be due to the fact that participants were always shown their feedback videos first. As the pilot study was prior to the self-awareness study, an effort was made to control this behaviour. Hence, we controlled the order in which the participants were shown the feedback videos in the current study, as described in section 3.6.3.

The three within-subjects analyses provide us with an initial view of the effects of the mimicry feedback video. It can be observed that the participants' general self-awareness as well as their self-awareness of their expressed emotions lowered after viewing the feedback video. These decreases are small and not statistically significant. However, participants reported a higher self-awareness of their non-verbal behaviour after viewing the feedback video compared to prior to viewing the feedback video. Furthermore, this increase is statistically significant. While this result seems promising, it has to be noted that this pilot study only considered seven participants. A more extensive study is needed to determine whether similar results can be observed when we introduce a control group.

### 3.6 Self-awareness Study

*3.6.1 Experimental Design.* The current study investigates the effects of a mimicry feedback video through an embodied conversational agent on the self-awareness of the participants. To that extent, the experimental design included one between-subjects variable: the feedback agent's behaviour (idle behaviour vs. mimic behaviour) and one within-subjects variable: time (negotiation 1 vs. negotiation 2). In the mimic group, the virtual Furhat robot mimics the participant's head pose, eye gaze, eyebrows and mouth movements. In the idle group, the agent will only exhibit the default idle behaviour of Furhat. Congruent to the pilot study, the agent will playback the participants' natural voices. Furthermore, the current study will consider both negotiation topics as described in section 3.4, as there are two negotiation rounds. Additionally, fig. 6 depicts the difference between the pilot and the current study.

*3.6.2 Participants.* A total of 64 participants were recruited for the self-awareness study. The participant's ages ranged between 18 - 35 years old (M = 25.984, SD = 3.150). Pairs of participants were randomly assigned to either the mimic condition or the idle condition. This resulted in 32 participants in the mimic group (7 females and 25 males) and 32 participants in the idle group (12 females and 20 males). Participants received remuneration of 10 EUR for their participation efforts. However, it was made clear that the remuneration should not have any influence on their decisions and answers during the study.

*3.6.3 Experimental Procedure.* Each pair of participants is led into a room where the researcher instructs them on where and how to sit in front of the cameras. Figure 8 illustrates the room setup. When the participants are situated, the researcher will sit out of sight of the participants in order to not influence the experiment. The researcher will still give instructions and explanations from behind the curtain.

The researcher starts by making a short calibration video as described in section 3.2 for the eye gaze. The researcher proceeds by briefly explaining the first negotiation topic to the participants. The participants are also given the opportunity to ask questions regarding the topic. Then, the researcher records the negotiation round between the participants. Each negotiation round is roughly five minutes. The researcher will signal the participants when there is one minute remaining. Participants are instructed to wrap the negotiation up and that a no agreement is not detrimental. During the feedback round, the participants are shown their feedback video, whose behaviour depends on the assigned condition. Additionally, participants view their opponent's feedback video as well. The researcher does not explicitly state to the participants that they are viewing their non-verbal behaviour, only that they are viewing themselves. Furthermore, we control for the order in which the videos are shown, i.e. first your own and then your opponents and vice versa. After the feedback video, the researcher will repeat these steps, excluding the feedback video, for the second negotiation round. Throughout the whole experiment, the participants are asked to fill in questionnaires at various stages, see fig. 9.

*3.6.4 Measures.* In order to determine whether mimicry through a conversational agent could increase a participant's self-awareness in a negotiation setting, several questionnaires are filled in. We created questionnaires 0 - 3 for the participants to self-report their self-awareness. Congruent with the pilot study, each question in the questionnaires is measured on a 7-point Likert scale. Two questions in each questionnaire involved the participants' self-awareness. We could determine whether the self-awareness increased in a pre- and post-test analysis. Our hypothesis was that the self-awareness of a person is increased after receiving feedback from a mimicking conversational agent.

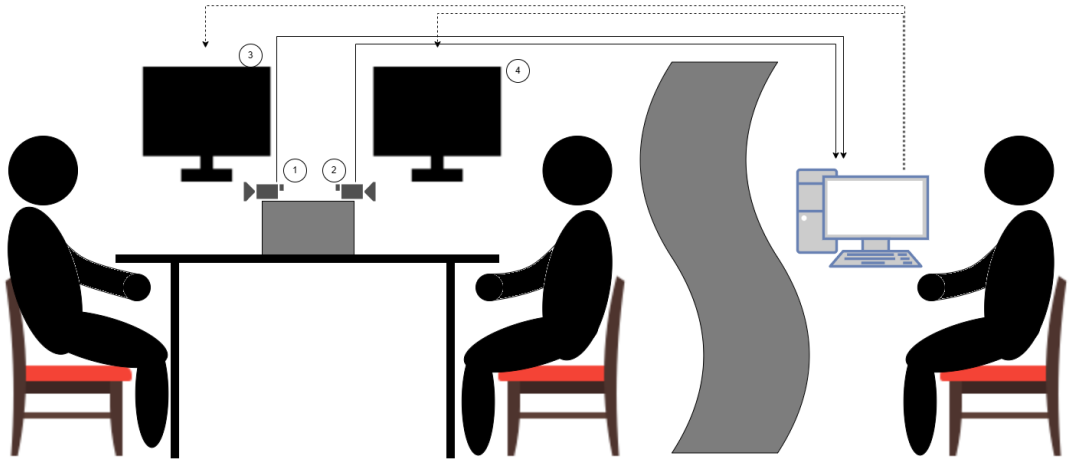



Fig. 8. Experimental setup: the participants at the table (left) and the researcher behind the curtain (right). Cameras (1) & (2) capture the participants' faces and screens (3) & (4) display the feedback video.

Additionally, ten questions on the accuracy of the mimicry in the feedback video were utilised in questionnaire 2 to determine whether the mimic condition provides better feedback than the idle condition. Our hypothesis was that the conversational agent, which exhibits non-verbal mimicry, provides better feedback than a non-mimicking agent.

Furthermore, the brief Self-Control Scale [67] (SCS) questionnaire and the Revised Self-Monitoring Scale [48] (RSMS) questionnaire was included as a pre- and post-test analysis to determine the deviation in the participants' self-awareness. Tangney et al. discusses the idea that self-control is a key factor in a person's well-being and success. They found that higher self-control results in better mental health and happier lives. We believe that the SCS questionnaire is appropriate for this study as the included 13 questions are directed towards self-control, productivity and self-awareness.

The RSMS questionnaire features 13 questions regarding a person's tendency to monitor and adjust their behaviour in various social situations. As the RSMS questionnaire aims to determine two measures, it can be split up into two sub-scales, sub-scale 1 (S1) and sub-scale 2 (S2), respectively. The former aims to assess to which degree a person is able to detect social cues. Then, the latter aims to assess to which degree a person is able to adjust their behaviour given the said detected social cues. As the current study is aimed to measure a participant's self-awareness, an interest is taken in the first sub-scale. A higher score on the RSMS(-S1) indicates that a person is more aware of their social situation. The RSMS(-S1) is therefore included in the study to determine a participant's ability to detect social cues.

Furthermore, the negotiation outcome is an important factor in determining whether the better feedback provided results in a better outcome. Therefore, the outcome of each negotiation round is recorded and analyzed. As described in section 3.7, the facial Auction Units of the participants are extracted and analysed to determine whether the type of feedback video has an effect on them. We considered smiling (AU12), eyebrow movement (AU01, AU02, AU04 and AU09) and eye gaze as dependent variables. Additionally, eye gaze and speech were matched by utilizing Whisper [60] and Pyannote [12, 13] in order to compute the participant's visual dominance during the negotiation. We can determine whether the visual dominance of a participant is affected by the type of feedback video as well as whether visual dominance has an effect on the negotiation outcome.

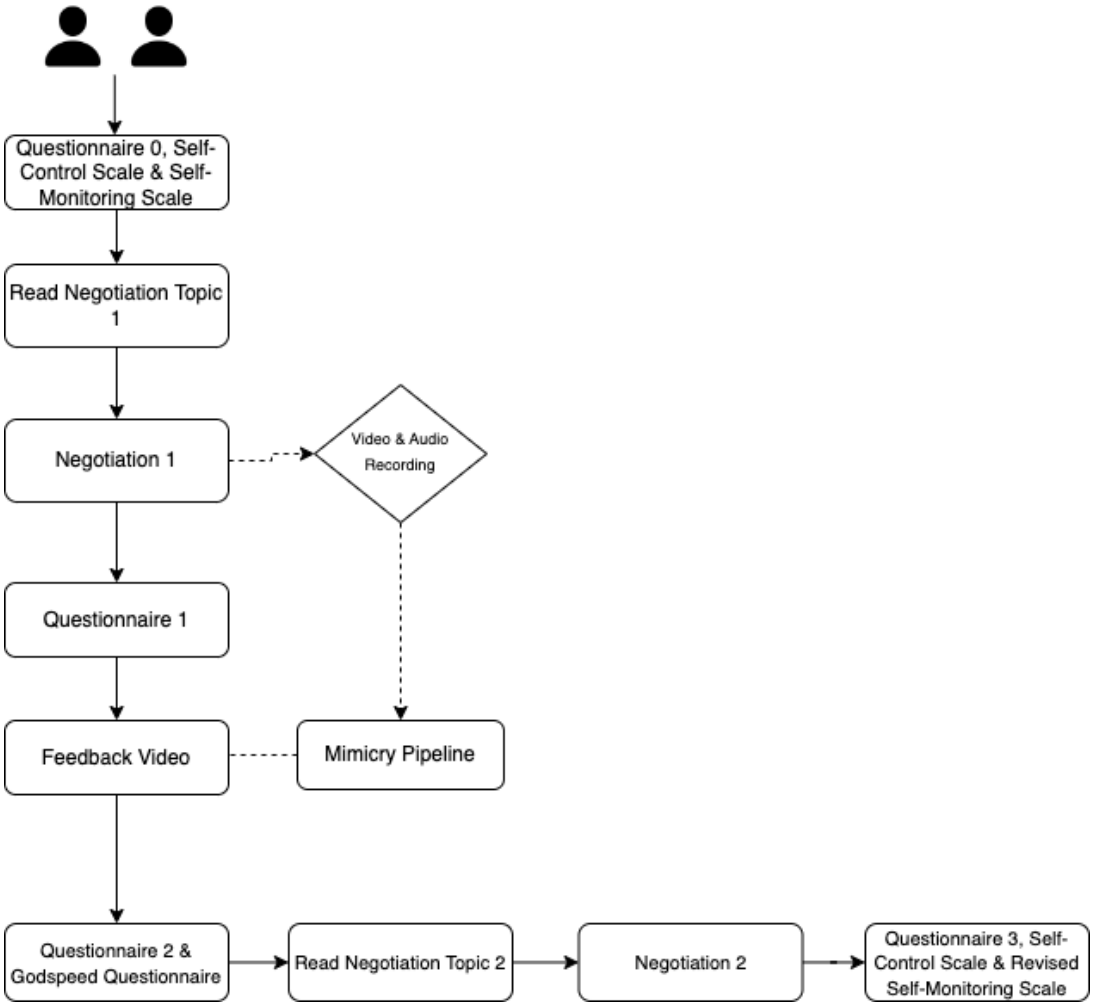



Fig. 9. Experimental Flow

Furthermore, Ekman's (1992) work determined six basic emotions, that being happy, sad, surprise, fear, anger and hate. These basic emotions are mapped to prototypical facial AUs [10, 26]. For example, if a frame of the video activates facial AUs 1, 4 and 15, then we note a sad expression of the participant during that particular frame. Each emotion is considered a dependent variable in the analysis in order to determine whether the self-awareness of non-verbal facial expressions has an effect on expressed emotions.

### 3.7 The Obtained Negotiation Dataset

The conducted study produced a rich dataset of negotiation interactions between the participants. The video footage of the negotiation rounds is recorded in MacOS's QuickTime Player. The recordings are exported in 720p with a framerate of 60 fps as MOV (.mov) files. The total dataset consists of 128 recordings, which results in roughly 20 GB in size.

| | | Mimic | |
|---|---|---|---|
| | Measure | Mean | SD |
| 1 | I recognized my own non-verbal expressions during the negotiation in the feedback video | 3.29 | 1.67 |
| 2 | I recognized my opponent's non-verbal expressions in the feedback video after the negotiation | 3.14 | 1.12 |
| 3 | I recognized myself in the feedback video | 3.71 | 1.83 |
| 4 | The feedback video of my opponent is similar to my actual opponent during the negotiation | 2.71 | 1.03 |

Table 3. Descriptive Statistics of various self-reported measures regarding recognition in the pilot study.

The dataset is utilised in the current study to extract and compare participants' facial Action Units, see section 4. Additionally, the dataset has potential for future studies on non-verbal facial expressions and negotiations.

## 4 RESULTS

### 4.1 Pilot Study

Table 3 depicts the descriptive statistics of several relevant questions asked regarding the recognition of the participants after viewing the feedback video. Correspondingly, fig. 10 depicts the results in a violin plot.

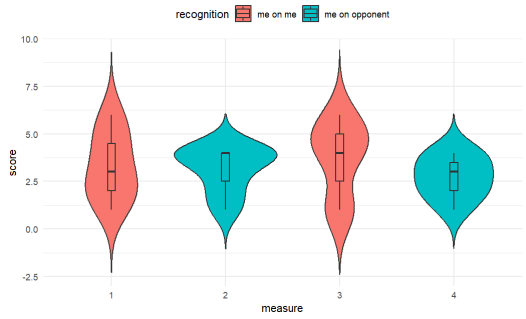



Fig. 10. Violin plot of the various self-reported measures regarding recognition found in table 3.

Three small within-subjects analyses regarding the participants' self-awareness of their expressed emotion, non-verbal behaviour and self-awareness in general were conducted. The statistical significance of the within-subjects design was determined by utilising a Paired Samples T-test.

(1) Q1.4 & Q2.7: "I was self-aware of my expressed emotion during the negotiation" & "I'm more self-aware of my emotion after viewing the feedback video"
(2) Q0.3 & Q2.6: "I'm self-aware of my non-verbal expressions during a negotiation" & "I'm more self-aware of my non-verbal expressions after viewing the feedback video"
(3) Q0.2 & Q2.8: "How self-aware are you?" & "Please rate your self-awareness after viewing the feedback video"

The first series regarding the self-awareness of expressed emotions resulted in a lower score ($M = 4.00, SD = 1.15$) after viewing the feedback video compared to the prior ($M = 4.29, SD = 0.49$). Furthermore, the decrease in self-awareness in expressed emotions is not statistically significant, $t = 0.55, df = 6, p > .5$. Figure 11 depicts a violin plot of the within-subjects design.

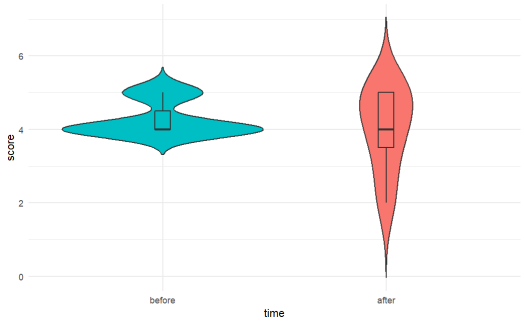



Fig. 11. Pilot study: participant's self-awareness of their expressed emotion prior to and after viewing the feedback video.

The second series regarding the self-awareness of the participants focuses on the non-verbal facial features expressed during the negotiation interaction. Participants reported a higher self-awareness after viewing the feedback video ($M = 4.71, SD = 1.38$) compared to prior to the feedback video ($M = 2.58, SD = 0.98$). This increase in self-awareness is statistically significant, $t = -4.67, df = 6, p < .01$. Figure 12 depicts a violin plot of the second within-subjects design.

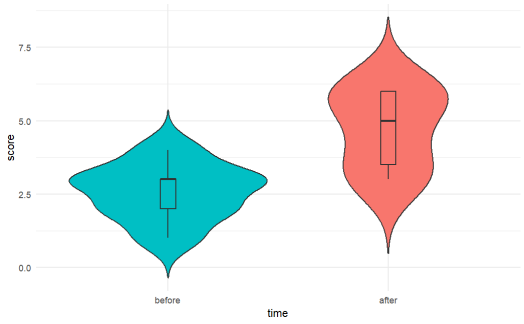



Fig. 12. Pilot study: participant's self-awareness of their non-verbal facial expressions prior to and after viewing the feedback video.

Participants reported a lower self-awareness after viewing the feedback video ($M = 3.71, SD = 0.95$) compared to prior to the feedback video ($M = 3.86, SD = 1.35$) in the third within-subjects design. This decrease is not statistically significant, $t = 0.19, df = 6, p > .5$. Figure 13 depicts the violin plot of the third within-subjects design.

### 4.2 Self-awareness Study

Several questions in the questionnaires were dedicated to establishing whether the mimicry pipeline is adequate, as mentioned in section 3.6.4. Specifically, does a conversational agent, which exhibits non-verbal mimicry, provide a better feedback video than a conversational agent that is not mimicking? We ran a statistical analysis utilising an

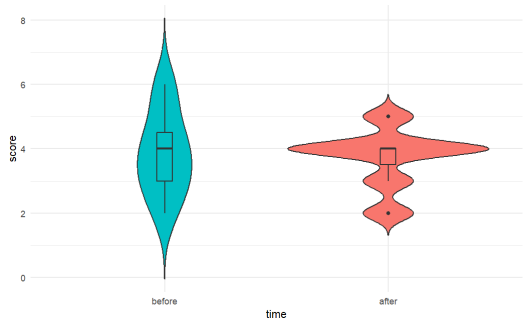



Fig. 13. Pilot study: participant's self-awareness prior to and after viewing the feedback video.

unpaired two-samples Wilcoxon Rank sum test with the independent between-subjects variable (feedback type) and a set of the participant's self-reported measures as the dependent variable. Table 4 shows the results of this analysis

We can observe that participants in the mimic group found that their feedback video provided a more accurate representation of their non-verbal facial expressions in terms of head poses, eyebrow movement and eye gaze. The differences in the self-reported accuracy scores are all statistically significant, excluding mouth movements. Furthermore, the participants in the mimic group reported a higher score in terms of recognizing themselves in the feedback video as well as recognizing their opponents in their feedback video compared to the idle group. Congruent with the results of the accuracy scores, these differences are also statistically significant. Additionally, participants in the mimic group report that they were better able to recognize their non-verbal facial expressions as well as their opponent's non-verbal facial expressions, in their corresponding feedback video, than the participants in the idle group. Moreover, it can be observed from table 4 these differences are also statistically significant.

| | Idle | | Mimic | | Wilcoxon Rank sum test |
|---|---|---|---|---|---|
| Measure | Mean | SD | Mean | SD | |
| I recognized myself in the feedback video | 2.03 | 1.68 | 4.28 | 1.02 | W = 135.5, p <.001 |
| I recognized my own non-verbal expressions during the negotiation in the feedback video | 2.09 | 1.75 | 4.25 | 1.19 | W = 161.5, p <.001 |
| I recognized my opponent's non-verbal expressions in the feedback video after the negotiation | 1.72 | 1.53 | 3.44 | 1.29 | W = 205, p <.001 |
| The feedback video of my opponent is similar to my actual opponent during the negotiation | 1.66 | 1.56 | 3.22 | 1.21 | W = 226.5, p <.001 |
| The accuracy of the mimicry of the Furhat robot | 1.94 | 1.56 | 3.47 | 1.05 | W = 232, p <.001 |
| The accuracy of the mimicry of the Furhat robot: head poses | 2.28 | 1.59 | 4.19 | 1.18 | W = 180, p <.001 |
| The accuracy of the mimicry of the Furhat robot: eyebrow movement | 2.75 | 1.69 | 3.69 | 1.18 | W = 328, p < .05 |
| The accuracy of the mimicry of the Furhat robot: eye gaze | 2.66 | 1.60 | 4.06 | 1.10 | W = 247.5, p <.001 |
| The accuracy of the mimicry of the Furhat robot: mouth movement | 1.66 | 1.54 | 2.31 | 1.33 | W = 372.5, p = .057 |

Table 4. Wilcoxon Rank sum test of the independent between-subjects levels: idle vs. mimic for various dependent self-reported measures.

We included three questions in the questionnaires to assess the self-awareness of the participants:

| | | q0 | | q2 | | q3 | |
|---|---|---|---|---|---|---|---|
| Measure | | Idle | Mimic | Idle | Mimic | Idle | Mimic |
| How self-aware are you? | Mean | 4.13 | 4.56 | 3.59 | 4.38 | 4.09 | 4.56 |
| | SD | 1.19 | 1.01 | 1.24 | 1.04 | 1.12 | 0.72 |

Table 5. Descriptive Statistics of the measure: How self-aware are you?

(1) I was more self-aware of my non-verbal expressions during the second negotiation compared to the first negotiation.
(2) How self-aware are you?
(3) I'm self-aware of my non-verbal expressions during negotiation.

The first question considers the between-subjects variable (feedback type). Participants in the mimic group reported a higher self-awareness score ($M = 4.25, SD = 1.37$), in regards to their non-verbal expressions in the second negotiation round compared to the first negotiation round, than participants in the idle group ($M = 3.44, SD = 1.64$), $W = 354, p < .05$.

The second and third question includes a within-subjects variable (time) alongside the between-subjects variable. Therefore, a two-way mixed ANOVA analysis is conducted on the two questions. Table 5 and table 6 give a descriptive statistics of questions two and three, respectively.

The second question was given at three different time levels, i.e. pre-test (q0), after the feedback video (q2) and post-test (q3). Figure 9 illustrates an overview of the different time levels during the experiment. There was a simple main effect of the between-subjects variable, $F(1, 62) = 6.466, p < .05$. Additionally, there was a simple main effect of the within-subjects variable, $F(2, 124) = 4.994, p < .01$. There was not a significant two-way interaction between the factors, $F(2, 124) = 1.093, p > .1$. A post-hoc analysis is performed in order to interpret the main effects of the significant factors. The p-values are adjusted using the Bonferroni correction method. Pairwise comparisons on the between-subjects factor reveal indeed that differences in the mimic group and idle group are significant, $p < .001$. A similar analysis on the within-subjects factor reveals that q0 vs q2 ($p < .05$) and q2 vs q3 ($p < .05$) are significant, but not q0 vs q3 ($p = 1$). Figure 14 depicts a violin plot of the analysis.

The third question was asked at four different time levels, i.e. pre-test (q0), after the first negotiation round (q1), after the feedback video (q2) and finally post-test (q3), see fig. 9. There is a statistically significant two-way interaction present on the between-subjects factor and the within-subjects factor, $F(3, 186) = 9.817, p < .001$. Post-hoc analysis reveals that the simple main effect of the condition is significant at time level q2 ($p < .001$), i.e. after viewing the feedback video. Further simple pairwise comparisons on condition at time level q2 reveal that the difference in score between the participants in the mimic group ($M = 4.5, SD = 1.24$) is significantly different compared to the participants in the idle group ($M = 2.31, SD = 1.47$), $p < .001$. Similarly, we investigated the effect of the within-subject factor on the between-subjects factor. It can be observed that the within-subjects factor has an effect on participants in the mimic group ($p < .001$) as well as the participants in the idle group ($p < .001$). Further simple pairwise comparisons revealed that statistically significant differences can be found between time levels q2 and q3 ($p < .01$) for participants in the idle group and between q0 vs q2 ($p < .01$) and q1 vs q2 ($p < .05$) for participants in the mimic group. Finally, the results indicate a non-significant difference between pre-test and post-test time levels for all participants. Figure 15 depicts a violin plot and corresponding p-values of the analysis.

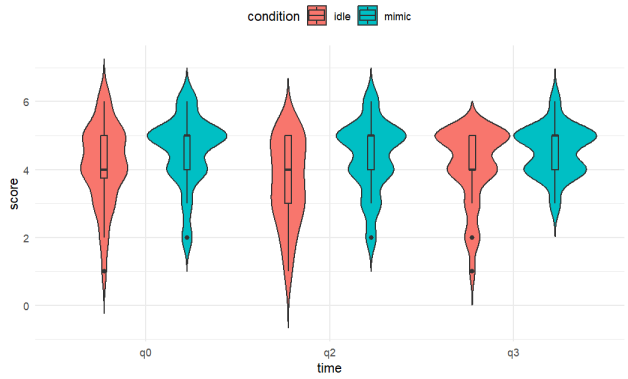



Fig. 14. Violin plot of self-reported measures on the question "How self-aware are you?".

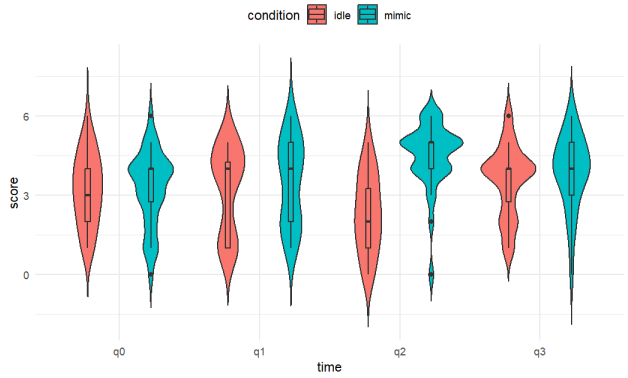



Fig. 15. Violin plot of self-reported measures on the question "I'm self-aware of my non-verbal expressions during negotiation".

| | | q0 | | q1 | | q2 | | q3 | |
|---|---|---|---|---|---|---|---|---|---|
| Measure | | Idle | Mimic | Idle | Mimic | Idle | Mimic | Idle | Mimic |
| I'm self-aware of my non-verbal expressions during negotiation | Mean | 3.22 | 3.28 | 3.25 | 3.50 | 2.31 | 4.50 | 3.56 | 3.91 |
| | SD | 1.36 | 1.42 | 1.61 | 1.63 | 1.47 | 1.24 | 1.34 | 1.40 |

Table 6. Descriptive Statistics of the measure: I'm self-aware of my non-verbal expressions during negotiation.

Further analysis included the facial emotions as well as the individual facial expressions as described in section 3.6.4. Each individual emotion and facial expression was considered as a dependent variable in a mixed ANOVA analysis with the type of feedback video as the between-subjects factor and time as the within-subjects factor.

There was a simple main effect of time on the participant's smiling behaviour, $F(1, 62) = 32.79, p < .001$. It was found that participants smiled less in the second negotiation round ($M = 35.16.SD = 29.41$) compared to the first negotiation round ($M = 47.43, SD = 33.07$) regardless of the type of feedback video received. Congruently, participants showed fewer expressions of happiness in the second negotiation round compared to the first. However, this difference is dependent on the type of feedback when the SCS score (low vs high) is included as a second between-subjects variable.

| | | Negotiation outcome | | |
|---|---|---|---|---|
| Condition | Expressed happiness | better | equal | worse |
| idle | less | 3 | 12 | 10 |
| | more | 1 | 2 | 4 |
| mimic | less | 0 | 13 | 3 |
| | more | 2 | 9 | 5 |

Table 7. Contingency table of the type of feedback video received and the negotiation outcome, going from round 1 to round 2, stratified over the expressed happiness difference of the same time period.

Specifically, there is a significant interaction term between the type of feedback and the SCS score of participants, $F(1, 60) = 4.39, p < .05$. A post-hoc analysis reveals that the simple main effect of the type of feedback is only significant for participants with a high SCS score, $p < .05$. More strongly, it was found that for participants with a high SCS score, the mean happiness score is lower in the idle group ($M = 11.30, SD = 10.33$) compared to the mimic group ($M = 21.09, SD = 22.32$), $p < .05$. Similar pairwise comparisons reveal a simple main effect of SCS score on the idle group, $p < .01$. It was found that for participants in the idle group, the mean happiness score is lower when they have a high SCS score ($M = 11.30, SD = 10.33$) compared to a low SCS score ($M = 27.90, SD = 30.74$), $p < .01$.

Additionally, the decrease in expressed happiness (barely) results in an association between the type of feedback video received and the negotiation outcome, $X^2_{MH} = 5.85, df = 2, p = .05$. When we control for the expressed happiness of the participants, we can observe that the idle group has more participants that performed better going from the first negotiation round to the second negotiation round. However, it can also be observed that the mimic group has fewer participants that performed worse between the two negotiation rounds compared to the idle group, see table 7 .

Multiple linear regression was utilised to test if the agent's behaviour and the participants' RSMS-S1 scores significantly predicted the delta in visual dominance between negotiation rounds 1 and 2. It was found that the agent's behaviour did not show significant main effect on the visual dominance delta, ($b = 3.074, SE = 8.776, p > .5$). Congruently, the participants' RSMS-S1 score is not a significant predictor, ($b = 3.811, SE = 5.915, p > .5$). However, the interaction between condition and RSMS-S1 is a significant predictor of the visual dominance delta, ($b = -18.451, SE = 8.906, p < .05$). It can be observed from the plot of the interaction effects, fig. 16, that the visual dominance lowered for the participants in the mimic group as the RSMS-S1 score increases. This decrease is statistically significant, ($b = -14.64, SE = 6.66, p < .05$). On the contrary, the visual dominance increased for the participants in the idle group as the RSMS-S1 score increased. However, this increase is not significant, ($b = 3.81, SE = 5.92, p > .5$).

## 5 DISCUSSION

We hypothesized that a mimicking conversational agent provides better feedback than the idle conversational agent (**H1**), as it was found that personalized feedback is more beneficial to participants in negotiation training [38]. Personalized feedback in terms of non-verbal behaviour would indicate mimicry of the participant's own non-verbal behaviour instead of non-personalized idle behaviour. Table 4 reveals various scores regarding the general accuracy of the feedback video as well as the participants' self-reported recognition of themselves and their opponents. The mimicking conversational agent scores significantly higher in all self-reported measures. It can be observed that participants seemed to recognize themselves better compared to their opponents' feedback video in the mimic group. The order in which the participants

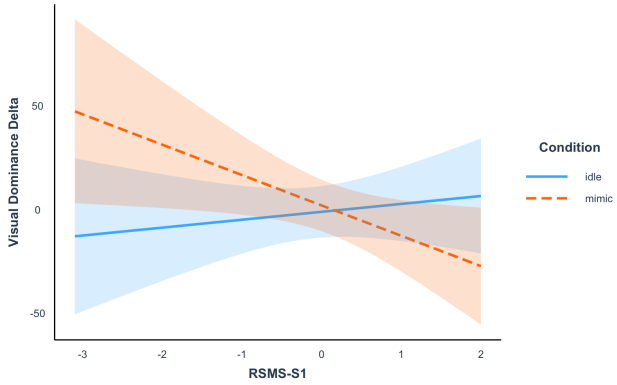



Fig. 16. Plot of the interaction effects between the agent's behaviour and the participants' RSMS-S1 score on the visual dominance delta.

viewed the feedback video is controlled for, as described in section 3.5.5, and the video generation for both videos is identical. It is reasonable to assume that the participants recognized themselves better due to the mere-exposure effect [77]. Participants were better able to recognize themselves as their own image is more familiar to them compared to the image of their opponents. While the results, found in table 4, support that a mimicking conversational agent is more personalized than an idle agent, it is not clear whether the personalized feedback is more beneficial to the participants in negotiation training compared to the non-personalized idle feedback video, as found in [38].

However, an association is found between the type of feedback video received and the negotiation outcome when we control for expressed happiness. It can be observed from table 7 that less expressed happiness does not lead to a better negotiation outcome, as both less expressed happiness and more expressed happiness count three occurrences of a better negotiation outcome. However, expressing less happiness does lead to a higher count of worse negotiation outcomes compared to expressing more happiness. Furthermore, the type of feedback video received reveals that the mimic group has fewer participants that performed worse between the two negotiation rounds compared to the idle group. These findings indicate that participants in the mimic group have less worse outcomes after viewing themselves during negotiations compared to the participants in the idle group.

Furthermore, we hypothesized that the self-awareness of a person is increased after receiving feedback from a mimicking conversational agent in negotiation training (**H2**). This hypothesis can be confirmed, based on the three presented questions regarding the participants' self-awareness as described in section 4.2. Participants in the mimic group reported a higher self-awareness score regarding their non-verbal expressions after viewing the feedback video compared to the idle group. This indicates that mimicry could aid participants in their capacity to self-regulate their non-verbal expressions. This finding aligns with [50].

Congruently, a repeated measures on the participants' self-awareness of their non-verbal expressions during the negotiation, as presented in the third question, reveals that the participants in the mimic group scored substantially higher in their self-awareness of their non-verbal expressions during negotiations compared to the idle group right after viewing the feedback video. This finding provides strong evidence that the feedback video has a positive effect on the participants' self-awareness of their non-verbal expressions, as this difference occurred right after receiving the treatment (feedback video). Similar to [8], participants became more self-awareness of their non-verbal behaviour

after receiving non-verbal feedback. However, our study confirms that this effect is also applicable to non-verbal facial expressions.

Furthermore, the second question's results reveal that the participants experienced a decrease in self-awareness between time levels pre-test and after the feedback video. However, it is evident that participants of both groups have a raised self-awareness between viewing the feedback video and the second negotiation round. Contrary to **H2**, the delta increase is larger for the participants in the idle group compared to the participants in the mimic group. Nonetheless, the increased self-awareness between viewing the feedback video and the second negotiation round indicates that participants' self-awareness is raised after repeated negotiation interactions regardless of the type of feedback video (idle vs mimic).

While the differences in the participants' self-reported self-awareness scores are statistically significant throughout various points in time during the study, the pre- and post-test scores are not. This indicates that the effect of the feedback video is temporary. However, this is not surprising as lasting behavioural change is often achieved over a longer period of engagement in behavioural change support systems. The research question of this study aims to determine whether the use of non-verbal mimicry through the medium of a conversational agent is a viable method to increase the self-awareness of a person in negotiation training. The results of **H1** support the notion that a mimicking conversational agent provides better feedback than a non-mimicking agent. Subsequently, viewing yourself during negotiation seems to immediately increase your self-awareness of your non-verbal behaviour as described by **H2**. Therefore, we believe that the use of non-verbal mimicry through the medium of a conversational agent is a viable method to increase the self-awareness of a person in negotiation training.

Finally, further findings indicate that participants tend to alter their non-verbal behaviour after viewing themselves during negotiations. Participants who received the idle feedback video showed significantly lower expressions of happiness and smiling gestures compared to the participants in the mimic group. It is possible that participants are mimicking their feedback video similar to [11, 45]. It could explain the lower frequency of smiles and happiness as the idle feedback video is less expressive compared to its counterpart. The lower frequency of expressed happiness is only evident when the SCS score is included. Specifically, participants with a high SCS score showed a decrease in expressed happiness. This might indicate that a high self-awareness is needed in altering one's non-verbal behaviour, which aligns with [63]. This is congruent with the analysis of the participants' visual dominance. Participants in the mimic group with a high RSMS-S1 score were significantly less visually dominant than participants with a low RSMS-S1 score. These findings align with the results obtained by [47, 63], who noted that participants expressed fewer facial expressions in the presence of a mirror. In our study, the mirror was substituted with a feedback video.

## 6 LIMITATIONS

The results obtained from this study show great promise in raising the self-awareness of participants through mimicry. However, several limitations can be found. The analysis of the participant's non-verbal behaviour considered solely the first minute of the negotiation interactions. It was found that participants tended to revert to their default non-verbal behaviour as the negotiation went on. This could be explained by habitual behaviour, as facial expressions are often automatic and reflexive. While participants could consciously attempt to change their non-verbal behaviour, their default facial expressions may reassert themselves after a short period of time. Furthermore, participants underwent a significant cognitive load during negotiations [30]. While it is evident that their self-awareness was raised, the cognitive strain of performing negotiation could divert their attention away from their non-verbal behaviour. This could lead to a reversion to their default non-verbal behaviour. Furthermore, the results of the current study were obtained in a

lab-controlled environment. The negotiation topics were pre-determined and participants did not have any personal stake in the negotiation interactions. While we attempted to simulate a real-world scenario, results might be inconsistent to the current study when participants do have an active stake in the negotiation rounds.

An additional limitation of this study is the choice of the utilised Furhat face. Participants were explicitly told that they were viewing themselves or their opponents on the feedback video during the experiment. As only two different Furhat faces were utilised, there were mismatches between some participants and the chosen face. This could introduce a bias when the participants are viewing a mismatched face on the feedback video. Future work should include a more diverse selection of faces in order to offer the participant the appropriate one.

## 7 CONCLUSION & RECOMMENDATIONS

As good negotiation skills are not explicitly taught to most people and positive and negative non-verbal behaviour might affect the outcome of negotiations, an effort is made to increase peoples' self-awareness of their non-verbal behaviour. Specifically, the current study focused on the use of non-verbal mimicry through the medium of a conversational agent to increase the self-awareness of a person in negotiation training. We hypothesized that a conversational agent, that exhibits non-verbal mimicry, provides better feedback than a conversational agent that does not exhibit mimicry. Additionally, we hypothesized that the self-awareness of a person is increased after receiving feedback from a mimicking conversational agent in negotiation training. It was found that a mimicking agent provides better feedback to the participants compared to an idle agent. Furthermore, the participants' self-awareness is raised after repeated negotiation rounds. This increase is regardless of the feedback video that the participant received. Additionally, participants altered their non-verbal facial expressions after viewing themselves during negotiations. Participants in both groups smiled less in the second negotiation round. Congruently, participants with a high SCS score and viewed the idle agent expressed less happy facial features compared to their counterparts in the mimic group. Additionally, the change in expressed happiness results in a relation to the negotiation outcome. Furthermore, participants with a low RSMS-S1 score are more likely to be visually dominant than participants with a high RSMS-S1 score in the second negotiation round regardless of the type of feedback received. However, when both negotiation rounds are considered, participants in the mimic group expressed less visual dominance when they had a high RSMS-S1 score compared to participants in the mimic group with a low RSMS-S1 score. Our results show that raising a person's self-awareness in negotiation training by utilising non-verbal mimicry through a conversational agent is feasible.

While the current study shows promise, section 6 introduced several limitations. As such, future research should focus on extending the experiment to multiple cycles of negotiation and feedback rounds or conduct multiple training sessions over an extended period of time to elicit a more permanent change in a person's non-verbal behaviour in negotiations. Furthermore, while the focus of the study was not on designing the perfect mimicking agent, improvements in non-verbal mimicry could influence the participants' perception of the agent. Therefore, slight improvements could be gradually introduced to the mimicry pipeline.

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## A HARVARD PON NEGOTIATION TOPICS

### A.1 Aerospace Investment

## Negotiation Topic 1: Aerospace Investment

This topic involves two companies. You will be playing either **the venture capital firm** or **the start-up company**. The following section provides a brief summary of the scenario.

A venture capital firm, Aerovent Capital, is considering a 100-million-dollar investment in a start-up company Earth Escape. Both parties are ought to negotiate a term sheet that structures a deal that protects their individual interests. However, the deal must also pave the way for a positive foundation for their future collaboration.

The negotiation will revolve around two variables:

1. Equity percentage

   Equity percentage is a term used to describe how much a person owns a company. For instance, if you have an equity stake of 50% in a company, then it means that you own 50% of said company.

2. Dividends

   Dividends is the distribution of earnings of a company to its shareholders. A higher dividend percentage means that you receive more money from a company.

While both parties want to collaborate, each party has their own desired outcome. You will only know the desires of your own role, i.e. you will not know the goals of the opposing party.

As the **venture capital firm**, you want to negotiate for:

- an agreement with the start-up company
- a minimum equity percentage of 40%
- a high as possible dividend percentage

As the **start-up company**, you want to negotiate for:

- an agreement with the venture capital firm
- a low as possible equity and dividend percentage
- however, you would like to keep equity over dividend. That is, you are willing to trade the dividend percentage for a lower equity percentage if needed.

**The venture capital firm** will start the negotiation with an offer of 50% equity and 15% dividends.

## A.2 Bullard Houses

# Negotiation Topic 2: Bullard Houses

This topic involves two companies. You will be playing either **the realtor company** or **the house-buyer** company. The following section provides a brief summary of the scenario.

A realtor company Downtown Realty owns a set of historic Bullard Houses. A total of 51 houses, however the houses are quite rundown and in disrepair. The Gothic Landmark Commission prevents Downtown Realty from demolishing the Bullard Houses. Thus, the realtor company seeks to sell the property and has already several offers on the table. A third buyer, Absentia, steps in and is convinced that her deal is the desired one.

The negotiation will revolve around two variables:

1. Price for the Bullard Houses
2. Percentage of the price for the Bullard Houses in (stock) shares.

Each party has their own desired outcome.

As the **realtor company**, you want to negotiate for:

- You have different projects running in tandem, meaning that you would prefer larger cash payments upfront in contrast to shares.
- Furthermore, you have several offers outstanding:
    1. Madison Properties offers a payment in cash.. Rough calculations result in a total value between **20 and 23 million dollar cash**. Thus 0% of the price is in shares.
    2. Gentrification Inc., intends to develop the property into 51 brownstones. However, the bulk of their offer lies in the form of notes which allows the seller to trade in the bond market for cash. The presented value would be roughly 14.4 million dollars. The total value would be, in addition to the cash payment upfront of 9.6 million dollars, **24 million dollars.** Thus, this results in a percentage of 60% of the price in shares.

As the **house-buyer company**, you want to negotiate for:

- You are somewhat aware of the other deals present and would have to make a strong case to the seller.
- You have to protect important details of your company and thus you can not tell too much to the seller, however, you have different projects running in tandem, thus you would like to buy the Bullard Houses by offering shares.
- You need to keep in mind a possible risk factor, thus reducing your maximum possible bid. Your maximum bid would be **27 million dollars**.
- Ideally you would like to offer 70% of the agreed price in shares.

**The house-buyer company** will start the negotiation with an offer of 25 million and 80% of the price in shares.