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Toward Strategic Training on Reading the Mind in the Eyes

Abstract
The Reading the Mind in the Eyes (RME) test was originally developed to help distinguish between persons with and without autism (Baron-Cohen et al., 2001). Recently the RME test has been shown to relate to a collective intelligence, defined as the ability of a group to perform a wide variety of tasks (Woolley et al., 2010). While these previous results may suggest that the RME measures a pre-determined ability it is an open question of whether RME test scores can be improved by strategically training participants to recognize the mental states of individuals from their faces. Preliminary work was done to develop training materials, specifically developing a set of RME-like practice questions. By documenting these efforts, this paper offers researchers an aide to developing their own materials related to the RME test. Future work will use these training materials to answer the question of whether RME scores can be improved through training, and how that may correlate with improved collective intelligence.

Disciplines
Operations Research, Systems Engineering and Industrial Engineering

Comments

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TOWARD STRATEGIC TRAINING ON READING THE MIND IN THE EYES

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The Reading the Mind in the Eyes (RME) test was originally developed to help distinguish between persons with and without autism (Baron-Cohen et al., 2001). Recently the RME test has been shown to relate to a collective intelligence, defined as the ability of a group to perform a wide variety of tasks (Woolley et al., 2010). While these previous results may suggest that the RME measures a pre-determined ability it is an open question of whether RME test scores can be improved by strategically training participants to recognize the mental states of individuals from their faces. Preliminary work was done to develop training materials, specifically developing a set of RME-like practice questions. By documenting these efforts, this paper offers researchers an aide to developing their own materials related to the RME test. Future work will use these training materials to answer the question of whether RME scores can be improved through training, and how that may correlate with improved collective intelligence.

INTRODUCTION

Imagine you have been handed a box of candy. Upon opening the box, you realize that instead of candy, it contains marbles. You close the box and place it on a table. Soon after, your friend enters the room and looks at the box. What do you think your friend assumes is in the box? An assumption that your friend believes the box to contain candy instead of marbles demonstrates Theory of Mind (ToM).

For some individuals, ToM does not come naturally. In these cases, training on images of faces improves their ability to recognize emotions and the beliefs of others (Adibsereshki, 2015). Because of the importance of the face and eyes in determining emotion, a test has been developed which assesses an individual’s ability to “read the eyes.” Scores on this test (the “Reading the Mind in the Eyes” – RME test) have been positively correlated with collective intelligence (i.e., a factor describing a group’s ability to perform a variety of tasks – like general intelligence for teams) and team success (Woolley, Chabris, Pentland, Hashmi, & Malone, 2010).

Though those findings have been disputed (Credé & Howardson, 2017), the connection between performance on the RME test and collective intelligence is of particular interest to teamwork researchers. If scores on the RME test strongly correlate with collective intelligence, would an increase in RME scores prompt a similar increase in collective intelligence? This question raises two research questions. First, can a person be trained to improve their RME score? Second, does increasing a person’s RME test score correlate to a concomitant increase in teamwork? This work documents an initial attempt to answer the first of these two questions and presents a process for establishing training for individuals on “reading the eyes” and thereby improving their performance on the RME test.

The following section will include a brief review of the relevant literature. Next, the methods for developing RME training, based upon existing ToM training, will be discussed. Following will be results of validating the training and a discussion of preliminary results.

BACKGROUND

ToM is defined as the ability to “infer others’ mental states and predict their behavior” (Inoue, et al., 2004, pp. 403). In the candy box example above, the inference is that the friend has not seen inside of the box, and the prediction is that they will assume it to contain candy. While inference of mental state had previously been assumed to be unobservable (Premack & Woodruff, 1978), this notion has been challenged. Facial expressions and gaze have been shown to be sufficient clues as to an individual’s mental state (Baron-Cohen, et al., 1992; Baron-Cohen, et al., 1995; Baron-Cohen, et al., 1997).

Theory of Mind and Autism Spectrum Disorders

For individuals with autism spectrum disorders (ASD), ToM is often impaired (Yamira, et al., 1998). These individuals may find it difficult to determine mental state by looking at facial emotions or observing actions. To improve these skills, interventions have been developed and widely implemented (Hess, et al., 2008). These interventions are generally conducted with children and involve the use of pictures to help individuals identify the desires and beliefs of others (Adibsereshki, et al., 2015). While this type of training has been found to reliably improve scores on measures of ToM, effects on social skills and emotion recognition have been small (Silver & Oakes, 2001; Turner-Brown, et al., 2008; Begeer, et al., 2011). Researchers have suggested that these results may be attributable to the lack of sensitivity of self-report social skills measurements, variations in IQ, and social style, and the severity of the participant’s disorder (Adibsereshki, 2015; Begeer, 2011).

ToM Training

However, more significant effects of training have been observed. Adibsereshki and colleagues (2015), administered ToM training over five weeks, with three intervention sessions each week. The first group of interventions focused on how people express basic emotions, like sadness, happiness, and fear, by teaching learners using faces, real and cartoon, and
then quizzing the participant on what they just learned. The second group of interventions used the same methods for more complex emotions but added storytelling to the intervention. Participants were asked to describe how the character in a story was feeling and explain why. The last three groups of intervention sessions taught desires and beliefs, first how to recognize them individually, and then how to put them together. This training was found to have a significant effect on the social skills of children with autism spectrum disorders (Adibsereshki, 2015). Thus, ToM training has been shown to be feasible and raises the question of whether training for the RME, which requires perception of more complex emotions, might also be feasible.

Reading the Mind in the Eyes (RME)

Human faces universally show six basic emotions: anger, disgust, fear, happiness, sadness, and surprise (Ekman, 1992a) (Figure 1). The presence of these emotions across cultures is explained by their value in dealing with fundamental life tasks (Ekman, 1994). For example, an expression of disgust may act as a warning to others. Humans also display many complex emotions, such as embarrassment or pride. These differ from basic emotions in that they are not “automatic” – they require significant cognitive processing and self-reflection.

The eyes are a particularly expressive part of the face; when reading complex emotions, it has been found that the eyes provide just as many clues as the full face and significantly more information than the mouth (Baron-Cohen, et al., 1997). From these results a test was developed to determine how well an individual could “read the eyes.” The “Reading the Mind in the Eyes” (RME) test presents participants with 36 photographs of the eye region (e.g., Figure 2). Participants then select the complex emotion they see in the eyes from a group of four words (Baron-Cohen, et al., 1997; Baron-Cohen, et al., 2001). The test assesses an individual’s ability to put themselves in the mind of another by mapping the choices of word to the photo and seeing a match (Baron-Cohen, et al., 2001). Women tend to score slightly (but significantly) higher on the test (28.6 vs 27.3 of 36) (Baron-Cohen, et al., 2001). Individuals with autism typically score lower (22 out of 36) than the general population (26 out of 36) (Baron-Cohen, et al., 2001).

Collective Intelligence and RME

Collective intelligence may be defined as the ability of a group to perform a wide variety of tasks (Woolley, et al., 2010). Collective intelligence can better predict group success than the intelligence of individual group members. As greater collective intelligence correlates to better team performance, factors that can influence collective intelligence are of great interest. One such factor, social sensitivity, is measured by the RME test. Scores on the RME test have been shown to be significantly positively correlated with greater collective intelligence and therefore, more successful groups (Woolley, et al., 2010).

METHODS

Before a person can be trained on reading the mind in the eyes, an effective training must be developed. This paper describes the development of the training intervention materials, which include:

1. Video 1, describing the basic emotions
2. An article describing the physical features of faces that cue emotions
3. Videos 2 and 3, featuring expressive faces of more complex emotions with quizzes on the characters' feelings
4. Video 4, featuring the RME test, plus a quiz.

To choose this training approach, the authors (1) examined methods for training ToM, (2) identified similar materials to adapt for RME training, and (3) established reliable answers to training materials in which there was no pre-defined answer to the question, “What emotion is the face showing?” Specifically, the following sections first introduce the identification of a training model and the materials, and then turn to the focus of this paper, delineating the development of reliably correct facial expression responses.

RME Training

Traditional ToM training involves establishing an ability to read emotions from the faces of others (Adibsereshki, et al., 2015). In contrast, the authors expect RME training to improve a person’s existing ability to read faces, so it is expected that a truncated training will produce a positive change in RME performance. For RME training, the authors considered only the first two groups of intervention sessions.
by Adibsereshki et al. (2015), the introduction of basic emotions and complex emotions, to be especially relevant to the RME task. The last three groups of ToM sessions focus on matching emotions and mental states to actions, which is less important for the RME.

Basic emotions have been argued to be more akin to families or categories of emotions with many variations within each family (Ekman, 1992a; Izard, 1992). Additional research has posited that complex emotions are composed multiple emotion dimensions (Cambria, Livingstone, & Hussain, 2012). Therefore, the authors thought it important to cover basic and complex emotions in the strategic training — first establishing a foundation for understanding basic emotion facial expressions and then to practice naming the family variants.

To teach about recognizing basic emotions, the authors identified Video 1, on reading facial expressions, which explained the emotions as well as showing them. In The Secrets to Decoding Facial Expressions (Mahoney, 2015), Vanessa Van Edwards first explains some of the theory behind basic emotions, then displays and explains each of the original six basic emotions (as in Ekman, 1992a) and the more recently identified contempt (as in Ekman, 1992b; Ekman & Heider, 1988), and finally quizzes the audience on the facial expressions.

After watching Video 1, participants are instructed to name the facial expressions featured at the end of the video, and feedback is given after the participant theorizes as to the emotions shown in the facial expressions. For example, in Figure 3, participants are given the randomly-ordered options (A) Happiness, (B) Contempt, (C), Fear, and (D) Confidence as identifiers for the emotion shown on Vanessa’s face. If the participant chooses any response other than (B), they will be given the feedback that their answer was incorrect, and that the correct answer was (B) Contempt.

![Figure 3. A face showing contempt (Mahoney, 2015)](image)

Establishing Reliably Correct Facial Expression Responses

For the video The Secrets to Decoding Facial Expressions (Mahoney, 2015), the emotions were predetermined and easily determined. However, the RME tests participants’ evaluations of complex emotions, such as hopeful or irritated, which are combinations of the facial expressions for seven basic emotions (Ekman, 1992b). The present section describes the methods used to choose materials and develop training question sets with feedback.

In ToM training, combinations of stories and cartoon representations of emotion expression become the stimuli for training (Adibsereshki et al., 2015). For the present training, the authors chose two five-minute Pixar short films as the stories for Videos 2 and 3, and used screen captures of characters showing emotion as stimuli for a practice quiz. Because the emotions shown by the characters in Partly Cloudy (Reher & Sohn, 2009) and Lifted (Sarafian & Rydstrom, 2006) are up to subjective interpretation, the authors chose to validate the emotions perceived in each film. Because the validation approach was identical for both films, only Partly Cloudy will be discussed.

When identifying emotions for which to capture stills, one author first watched the film and noted changes in facial expression. Then, 11 facial expression frames were captured and saved to a folder with generic filenames. Each face was ascribed an emotion word from the list of complex emotions presented in Baron-Cohen et al. (2001). Cognizant of the problems with relying on a single person’s judgement, the authors scrapped this initial categorization in favor of a different approach.

![Figure 4. Example stills from Partly Cloudy and Lifted (Reher & Sohn, 2009; Sarafian & Rydstrom, 2006).](image)

To improve the categorization, independent judges sorted through all 93 possible emotion words used in the original the RME test into eight categories. The eight categories were the seven basic emotions discussed previously (as noted in Ekman, 1992b) and one “Other” category. The goal was to sort the complex emotions into the basic emotion category. This would provide a mapping that enabled the complex emotion words to be paired with the 11 pictures with more confidence that they match the emotion displayed.

Finally, these eight categories were paired with each of the 11 pictures in an online survey which was sent to unaffiliated judges. Once the judge selected a category, he or she was instructed to select a complex emotion from the list. While the authors strived for one list per picture, if consensus could not be made regarding which list best fit a photo, the two best lists were included. The words in these lists became the pool of complex emotions per photograph from which the final coding effort was conducted.

RESULTS

Original Effort

The original attempt using independent coding to assign emotions to the cartoon facial expressions revealed some
nuance specific to the task. Because complex emotion is so heavily tied to culture, and therefore language (Jack, Garrod, Yu, Caldara, & Schyns, 2012), the authors had a difficult time recognizing and naming the emotions or mental states present in the screen captures. That is, sometimes the emotion words that the authors had come to associate with the feeling represented in an image were not present in the original RME list. This resulted in a lot of disagreement surrounding the expressed emotions. In some cases, even though the authors were instructed to choose only words from the RME test, words that seemed more representative were chosen. Therefore, the authors altered their approach, first structuring the emotion words into lists depending on the basic emotion closest to the complex emotion’s facial expression, then using those lists to focus the discussion.

**Sorting Lists of Emotions and Assignment to Faces**

First, the 93-item list of complex emotions was sorted into categories corresponding to the closest basic emotion (Ekman, 1992b). Because the number of choices had been narrowed, there was more agreement than there had been in the previous iteration. Instead of disposing of the items on which there was continued disagreement, the authors chose to assign them to each list to which they had been assigned.

The generated lists were then independently assigned to each of the 11 faces, and choices were discussed. Where there was not consensus, the top two lists were included in an online survey. At this point in the process, the authors recognized that their approach had been too broad, and they met again to decide on the correct spot for each word, as well as the correct list for each face. After narrowing the options, the task of assigning complex emotions to facial expressions was re-approached. Unfortunately, this approach proved to be too open to error and the authors ultimately decided to recruit broadly and use a sliding scale to determine the degree to which each complex emotion was present in each image.

**Assigning complex emotions to images**

After approaching the problem of valid feedback from the various angles described above, the authors again changed their tactic. Instead of supplying long lists to a limited set of judges, smaller lists of a random sample of complex emotion words for each image were sent out via snowball sampling on social media and through email.

To do this, the authors first eliminated the “other” emotion list, sorting the emotions that weren’t already present in the set of lists so that no complex emotions were lost. Then, each image, which was previously matched with an emotion list as described above, was presented to participants (n = 136) in an online survey. Images were presented with a random mix of five complex emotion words, which participants each rated on a scale of 1-7, where 1 represented “Does Not Fit at All” and 7 represented “Fits Very Well.” The complex emotion word with the highest mean score was then chosen as the “correct” answer for the image, while the three complex emotion words with the lowest mean scores were chosen as the distractor choices.

To account for the possibility of multiple-emotion faces, those faces on which there is disagreement will be discarded. The remaining faces will be used in the strategic training portion of a larger study of the ability to train participants on the RME test.

**DISCUSSION**

Just as with Theory of Mind, RME training could have consequences for individuals who have trouble understanding what someone is thinking or feeling. Additionally, since the RME test has been shown to be potentially related to an individual’s ability in a team setting (Woolley et al., 2010), training on the RME may also have an impact on team outcomes.

If training influences scores on the RME test, there are additional implications for collective intelligence. For the longest time, one’s intelligence was believed to be completely genetically predetermined; however, further research has found that while it is largely hereditary, and that there are some ways in which intelligence can be improved via training (Duckworth, Hunt, Jaeggi, Stough, & Johnson, 2012). If a measure related to collective intelligence can be improved, this could have implications for the existence and/or organization of collective intelligence.

Some limitations of this early effort are revealed in the decision to categorize based on Ekman’s (1992b) emotions. One of the judges in this effort remarked that the process was made difficult by the overwhelming negative connotations of these universal emotions. Moving forward, the authors intend to utilize more of the theory established by Plutchik (2001) and expanded by Cambira et al. (2012). In doing so, the work could add additional insight to affective computing efforts, perhaps as a starting point for machine-learning algorithms on the subject.

Additionally, this preliminary effort uncovered nuanced difficulties with developing a suitable method for training individuals on recognizing complex emotions and mental states. While an approach similar to that of Baron-Cohen and colleagues (1992) in their development of the RME test was preferable, the authors could not reconcile the feeling that they were not qualified to determine the complex emotions of faces, and instead turned to a sample approach. If the strategic training were to be refined, the authors would identify literature-identified precocious groups from which experts could be identified. These experts would be used to develop the “correct” answers, combining the approaches described in this preliminary paper.

The overarching project of evaluating RME trainability is still in its early stages. However, the results of the study will have positive implications for Theory of Mind and for teamwork.

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